Final
Implementation Plan for the Guadalupe River Project Mitigation and Monitoring Plan

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Contents

Page

Chapter 1 **Introduction** 1-1
1.1 Purpose of the Implementation Plan 1-1
1.2 Guadalupe River Project Overview 1-1
1.2.1 Background 1-1
1.2.2 Description 1-2
1.2.3 Location 1-2
1.2.4 Role of Adaptive Management 1-3
1.3 How to Use This Document 1-4
1.3.1 Organization 1-4
1.3.2 Audience 1-5
1.3.3 Intent as a Living Document 1-5
1.3.4 Specific Tools for Document Use 1-6

Chapter 2 **Schedule** 2-1
2.1 Introduction 2-1
2.2 How to Use Tables 2-1–2-5 2-2
2.2.1 Overview 2-2
2.2.2 Table 2-1 (Schedule for Indicator Monitoring by Month and Monitoring Year through Monitoring Year 10) 2-2
2.2.3 Table 2-2 (Monitoring Year Determination for Monitoring Locations Based on Project Construction or Mitigation Installation Completion Date) 2-3
2.2.4 Table 2-3 (Schedule for Indicator Monitoring by Monitoring Location and Calendar Year) 2-3
2.2.5 Table 2-4 (Estimated Data Collection Hours by Indicator and Unit Type) 2-3
2.2.6 Table 2-5 (Estimate of Annual Hours by Monitoring Indicator and Professional Expertise) 2-3
2.3 Rationale Used to Create Tables 2-1–2-5 2-4
2.3.1 Introduction 2-4
2.3.2 Table 2-1 2-4
2.3.3 Table 2-2 2-4
2.3.4 Table 2-3 2-5
2.3.5 Table 2-4 2-8
2.3.6 Table 2-5 2-8

Chapter 3 Data Management 3-1
3.1 Introduction 3-1
3.2 System Overview 3-1
  3.2.1 System Access 3-2
3.3 System Requirements 3-3
  3.3.1 Hardware 3-3
  3.3.2 Software 3-4
  3.3.3 Staff Qualifications 3-4
3.4 System Design 3-5
  3.4.1 Graphical User Interface 3-5
  3.4.2 Database Design 3-6
3.5 Quality Assurance 3-16
  3.5.1 Mandatory Fields 3-17
  3.5.2 Data Format Checks 3-17
  3.5.3 Lookup Values 3-17
  3.5.4 Incomplete or Illegible Data 3-17
  3.5.5 Data Entry Report and Field Form Comparison 3-17

Chapter 4 Riparian Vegetation 4-1
4.1 Introduction 4-1
  4.1.1 Staff Qualifications 4-1
4.2 Survival Indicator 4-3
  4.2.1 Data Collection 4-3
  4.2.2 Data Management 4-6
  4.2.3 Data Analysis and Evaluation 4-8
4.3 Health and Vigor Indicator 4-12
  4.3.1 Data Collection 4-12
  4.3.2 Data Management 4-18
  4.3.3 Data Analysis and Evaluation 4-19
4.4 Qualitative Assessment 4-21
  4.4.1 Data Collection 4-22
  4.4.2 Data Management 4-24
  4.4.3 Data Analysis and Evaluation 4-25
4.5 Natural Recruitment Indicator 4-26
  4.5.1 Data Collection 4-26
  4.5.2 Data Management 4-29
  4.5.3 Data Analysis and Evaluation 4-30
4.6 Native Vegetative Cover and Nonnative Vegetative Cover Indicators 4-31
  4.6.1 Data Collection 4-32
  4.6.2 Data Management 4-39
  4.6.3 Data Analysis and Evaluation 4-42
4.7 Tree Height Indicator 4-47
  4.7.1 Data Collection 4-47
  4.7.2 Data Management 4-52
  4.7.3 Data Analysis and Evaluation 4-54
4.8 Tree Basal Area Indicator 4-55
  4.8.1 Data Collection 4-56
  4.8.2 Data Management 4-59
  4.8.3 Data Analysis and Evaluation 4-60

Chapter 5 **SRA Cover** 5-1
5.1 Introduction 5-1
5.1.1 Staff Qualifications 5-1
5.2 Survival Indicator 5-3
5.2.1 Data Collection 5-3
5.2.2 Data Management 5-7
5.2.3 Data Analysis and Evaluation 5-8
5.3 Health and Vigor Indicator 5-11
5.3.1 Data Collection 5-12
5.3.2 Data Management 5-17
5.3.3 Data Analysis and Evaluation 5-19
5.4 Qualitative Assessment 5-21
5.4.1 Data Collection 5-21
5.4.2 Data Management 5-23
5.4.3 Data Analysis and Evaluation 5-24
5.5 Natural Recruitment Indicator 5-25
5.5.1 Data Collection 5-26
5.5.2 Data Management 5-28
5.5.3 Data Analysis and Evaluation 5-29
5.6 Nonnative Vegetative Cover Indicator 5-31
5.6.1 Data Collection 5-31
5.6.2 Data Management 5-35
5.6.3 Data Analysis and Evaluation 5-37
5.7 Shaded Stream Surface Indicator 5-39
5.7.1 Data Collection 5-39
5.7.2 Data Management 5-42
5.7.3 Data Analysis and Evaluation 5-43
5.8 Bank Stability Indicator 5-45
5.8.1 Data Collection 5-45
5.8.2 Data Management 5-49
5.8.3 Data Analysis and Evaluation 5-51
5.9 Instream Cover Indicator 5-52
5.9.1 Data Collection 5-52
5.9.2 Data Management 5-57
5.9.3 Data Structure and Entry for Aerial Photographs 5-58
5.9.4 Data Analysis and Evaluation 5-59
5.10 Channel Bottom Stability Indicator 5-60
5.10.1 Data Collection 5-60
5.10.2 Data Management 5-64
5.10.3 Data Analysis and Evaluation 5-65

Chapter 6 **Water Temperature** 6-1
6.1 Introduction 6-1
6.1.1 Chapter Organization 6-1
6.1.2 Important Definitions 6-2
6.1.3 Summary of Water Temperature Analysis Process 6-6
6.1.4 Staff Qualifications 6-7
6.2 Data Collection 6-8
6.2.1 Measured Water Temperature 6-9
6.2.2 Solar Heat Transfer 6-17

6.2.3 Stream Channel Geometry 6-30
6.2.4 Stream Flow..6-38
6.2.5 Hourly Meteorological Data 6-45
6.3 JSATEMP Stream Temperature Model Simulations...........6-46
6.3.1 Description of JSATEMP Stream Temperature Model 6-46
6.3.2 Simulated Water Temperature—Postproject Conditions..6-46
6.3.3 Simulated Water Temperature—No-Project Conditions..6-50
6.3.4 Data Management and Reporting...........................6-51
6.4 Monthly Thermal Suitability Indicator..................................6-51
6.4.1 Data Collection 6-52
6.4.2 Data Management 6-52
6.4.3 Data Analysis and Evaluation 6-53
6.5 Short-Term Thermal Suitability Indicator.............................6-57
6.5.1 Data Collection 6-58
6.5.2 Data Management 6-58
6.5.3 Data Analysis and Evaluation 6-59

Chapter 7 Anadromous Fish Spawning Habitat 7-1
7.1 Introduction 7-1
7.1.1 Staff Qualifications..7-1
7.2 Spawning Gravel Abundance Indicator.................................7-2
7.2.1 Data Collection 7-3
7.2.2 Data Management 7-7
7.2.3 Data Analysis and Evaluation 7-9
7.3 Spawning Gravel Quality Indicator.....................................7-11
7.3.1 Data Collection 7-11
7.3.2 Data Management 7-14
7.3.3 Data Analysis and Evaluation 7-15

Chapter 8 Anadromous Fish Passage and Rearing Habitat.........................8-1
8.1 Introduction 8-1
8.1.1 Staff Qualifications..8-1
8.2 Depth and Velocity Indicator 8-2
8.2.1 Data Collection 8-3
8.2.2 Data Management 8-12
8.2.3 Data Analysis and Evaluation 8-14
8.3 Vertical Barrier Indicator 8-15
8.3.1 Data Collection 8-15
8.3.2 Data Management 8-19
8.3.3 Data Analysis and Evaluation 8-21
8.4 Rearing Habitat Diversity Indicator 8-21
8.4.1 Data Collection 8-22
8.4.2 Data Management 8-26
8.4.3 Data Analysis and Evaluation 8-28

Chapter 9 Anadromous Fish Occurrence 9-1
9.1 Introduction 9-1
9.1.1 Staff Qualifications 9-2
9.2 Adult Migration and Spawning Indicator 9-3
9.2.1 Data Collection 9-3
9.2.2 Data Management 9-9
9.2.3 Data Analysis and Evaluation 9-11
9.3 Juvenile Rearing Indicator 9-12
9.3.1 Data Collection 9-12
9.3.2 Data Management 9-20
9.3.3 Data Analysis and Evaluation 9-22

Chapter 10 Guadalupe River Annual Mitigation Monitoring Report Format and Content 10-1
10.1 Purpose 10-1
10.2 Suggested Format and Content 10-1
10.3 Schedule 10-3
10.4 Distribution 10-3

Chapter 11 Report Preparation 11-1
11.1 Introduction 11-1
11.1.1 Jones & Stokes 11-1
11.1.2 U.S. Army Corps of Engineers 11-2
11.1.3 Santa Clara Valley Water District 11-2

Chapter 12 References 12-1
12.1 Printed References 12-1
12.2 Personal Communications 12-3

Appendix A. Glossary

Appendix B. Relationship Diagrams of Primary Data and Metadata Tables for Indicators/Environmental Condition Parameters

Appendix C. Aerial Photograph Control Points

Appendix D. Data Collection Forms

Appendix E. Approach to Locating Permanent, Field-Marked Sampling Plots and Line Transects Identified in the February 2001 Guadalupe River Project Mitigation and Monitoring Plan

Appendix F. Plot Stem Maps for Riparian Vegetation and SRA Cover Sampling Plots

Appendix G. Benchmarks Used during Channel Bottom Stability Monitoring

Appendix H. Instructions for Using the JSATEMP Stream Temperature Model

Appendix I. Supplemental Biological Opinion for the Guadalupe River Project from the National Oceanic and Atmospheric Administration National Marine Fisheries Service Dated October 28, 2003

Tables

Page

1-1 Summary of Individual SRA Cover and Riparian Vegetation Planting Areas Located in the Onsite Mitigation Area ....Follows 1-4

1-2 Summary of Individual SRA Cover Mitigation Planting Areas in the Offsite Mitigation Areas: Reach A and Guadalupe Creek..Follows 1-4

1-3 Corresponding Nomenclature for SRA Cover Sampling Plots and Planting Areas in the Implementation Plan (IP) and Mitigation Monitoring Plan (MMP)......................................Follows 1-4

2-1 Schedule for Indicator Monitoring by Month and Monitoring Year through Monitoring Year 10..Follows 2-2

2-2 Monitoring Year Determination for Monitoring Locations Based on Project Construction or Mitigation Installation Completion Date ....Follows 2-2

2-3 Schedule for Indicator Monitoring by Monitoring Location and Water Year...Follows 2-2

2-4 Estimated Data Collection Hours by Indicator and Unit Type...Follows 2-2

2-5 Estimate of Annual Hours by Monitoring Indicator and Professional Expertise ....Follows 2-2

3-1 Primary Data Tables in the Relational Database Management System...3-7

3-2 SCVWD GIS Layer-Naming Convention 3-12

4-1 Numeric Rating of Foliage Health and Vigor 4-16

4-2 Numeric Rating of Wood Health and Vigor...4-17

4-3 Numeric Rating for Root Crown Health and Vigor................................4-18

4-4 Natural Recruitment Abundance Scores 4-28

4-5 Cover Class by Visually Estimated Percent Relative Cover 4-36

4-6 Location of Photo Points for Sampling Plots.......................................4-49

5-1 Numeric Rating of Foliage Health and Vigor 5-15

5-2 Numeric Rating of Wood Health and Vigor..5-16

5-3 Numeric Rating of Root Crown Health and Vigor 5-17

5-4 Natural Recruitment Abundance Scores 5-28

5-5 Cover Class by Visually Estimated Percent Relative Cover 5-33

5-6 Terms Used to Describe Bank Stability Conditions 5-47

5-7 Number of Transect Bands in Each Stream Segment Based on Length of Segment in Water Year 2001 5-54

6-1 Location of Model Segments Affected by Project Construction and Mitigation 6-4

6-2 Types of Data Used in the Current-Postproject and No-Project Simulations of the JSATEMP Stream Temperature Mode 6-5

6-3 Description of Shade Terms Used in the JSATEMP Stream Temperature Model 6-28

6-4 Landmarks for Determining Location of Cross Sections for Stream Channel Geometry Measurements..6-33

6-5 Gage Locations for Stream Flow Data Used in the JSATEMP Stream Temperature Model..6-41

6-6 Description of JSATEMP Stream Temperature Model Variables Used for the Monthly Thermal Suitability Indicator 6-54

6-7 Suitability Indices for Water Temperature Effects on All Life Stages of Steelhead and Chinook Salmon..6-55

6-8 Maximum Suitable Water Temperatures (°F) for Each Life Stage of Steelhead and Chinook Salmon. 6-60

7-1 Classification of Gravel by Average Size ... 7-7

7-2 Numeric Categories of Substrate Particle Size for Steelhead and Chinook Salmon Spawning Habitat ... 7-13

8-1 Numeric Scores Used for Riffle/Run Habitat Types ... 8-25

8-2 Numeric Scores Used for Pool Habitat Types ... 8-26

9-1 Life-Stage Assessment Protocol for Juvenile Salmonids ... 9-19

Figures

Follows Page

1-1 Guadalupe River Project Vicinity Map 1-2

1-2 Segments 1, 2, 3A, 3B, and 3C, and Woz Way to Park Avenue Bypass 1-2

1-3 Offsite Mitigation Areas 1-4

3-1 Guadalupe Environmental Monitoring System (GEMS) Overview 3-2

3-2 GEMS Main Menu 3-6

3-3 GEMS Main Data Entry Menu and Riparian Vegetation Monitoring Indicators Data Entry Menu 3-6

3-4 Sample GEMS Data Entry Form 3-6

4-1 Preferred Location of Identification Tag and Standard Labeling 4-6

4-2 Measuring Vegetative Cover Using the Line Intercept Method 4-38

4-3 Measuring Tree Height Using a Clinometer 4-52

4-4 Location of the Four Possible Photo Points for a Riparian Vegetation Sampling Plot 4-52

4-5 Measuring Tree Diameter Using a Biltmore Stick 4-62

5-1 Typical Streambank Features in Segments 1–3, Reach A, and Guadalupe Creek 5-48

5-2 Examples of Bank Stability Segments 5-48

5-3 Determining Percent Instream Cover at a Transect Band 5-56

5-4 Plan View of Cross-Section Survey 5-62

5-5 Profile View of Stream Channel Facing Downstream 5-64

6-1 Basis for Adjusting Parameters in the JSATEMP Stream Temperature Model 6-6

6-2 Water Temperature Analysis for Steelhead and Chinook Salmon 6-6

6-3 Schematic Diagram of Water Temperature Logger Case 6-10

6-4 Model Segments Used in the JSATEMP Stream Temperature Model, Including Water Temperature Monitoring Sites and Stream Flow Gaging Stations 6-10

6-5 Placement of Water Temperature Logger Case in Stream Channel 6-12

6-6 Measuring Stream Channel Geometry 6-34

6-7 Sample Calculation of Cross-Sectional Area 6-36

6-8 Total Thermal Suitability Units for 2 Steelhead Life Stages Simulated for the Dry/Median Year in All Stream Segments Affected by the Guadalupe River Project 6-56

7-1 Determining the Proportion of Spawning Gravel at Elevational Units 7-6

7-2 Determining Particle Size for Spawning Gravel Quality Sample 7-14

8-1 Depth Barrier Field Measurements, Using Shallow Riffle as an Example 8-8

8-2 Velocity Barrier Field Measurements, Using Notched Weir as an Example 8-8

8-3 Vertical Barrier Field Measurements, Using Notched Weir as an Example 8-18

9-1 Coded-Wire-Tag Recovery Form 9-8

Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
CWA	Clean Water Act
cfs	cubic feet per second
DFG	California Department of Fish and Game
DST	daylight savings time
dbh	diameter at breast height
ESA	Endangered Species Act
fps	feet per second
GIS	geographic information systems
GB	gigabytes
GUIs	graphical user interface
GEMS	Guadalupe Environmental Monitoring System
Project	Guadalupe River Project
IP	Guadalupe River Project Mitigation and Monitoring Plan
I-280	Interstate 280
I-880	Interstate 880
JSATEMP model	JSATEMP stream temperature model
LWE	left water's edge
lf	linear feet
MB	megabytes
MHz	megahertz
MMP	Guadalupe River Mitigation and Monitoring Plan
ODBC	object database connectivity
PST	pacific standard time
PCs	personal computers
RAM	random access memory
RDBMS	relational database management system
RWE	right water's edge
SCVWD	Santa Clara Valley Water District
SRA	shaded riverine aquatic
SQL	system query language
Corps	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

Chapter 1
Introduction

Guadalupe River, Reach A

1.1 Purpose of the Implementation Plan

The purpose of the *Implementation Plan for the Guadalupe River Project Mitigation and Monitoring Plan* (IP) is to serve as a stand-alone document that provides detailed instructions for collecting, managing, and analyzing and evaluating environmental monitoring data for the Guadalupe River Project (Project). The IP builds on and is a continuation of the *Guadalupe River Project Mitigation and Monitoring Plan* (MMP) (U.S. Army Corps of Engineers, 2001a). The IP provides details and refinement of the general monitoring methods and schedule described in the MMP. The IP describes how to practically apply the MMP's monitoring program to the Project's construction and mitigation areas. The IP is intended to direct the mitigation monitoring committed to by the U.S. Army Corps of Engineers (Corps), as the lead Federal sponsor, and the Santa Clara Valley Water District (SCVWD), as the lead nonfederal sponsor, for the Project.

1.2 Guadalupe River Project Overview

1.2.1 Background

The multipurpose Project is under phased construction along the Guadalupe River in downtown San Jose, California (figure 1-1). When all Project phases are complete, the Project will provide flood protection up to the design flow of 17,000 cubic feet per second (cfs) to downtown San Jose and surrounding areas, while mitigating adverse Project effects on anadromous fish and riparian habitat, including shaded riverine aquatic (SRA) cover. A recreation component is also included as part of the Project.

The Project was authorized by Congress in 1986 to provide flood protection and amended in 1990 and 1991 to add additional environmental protection and to include components for recreation. Construction of the Project began in 1992 after State water quality certification was obtained, as required under Section 401 of the Clean Water Act (CWA). Conditions of the 1992 water quality certification required a final mitigation and monitoring plan be developed for the Project to address adverse effects on anadromous fish and riparian habitat. Several versions of a mitigation and monitoring plan have been prepared in response to water quality certification requirements as the Project design has been refined from the original design authorized in 1986. For the purposes of this IP, the final mitigation and monitoring plan is considered to be the February 2001 version of the MMP (U.S. Army Corps of Engineers, 2001a) and has been used exclusively in the preparation of this IP. The MMP includes environmental mitigation and monitoring required as part of the water quality certification under the CWA, as well as environmental mitigation and monitoring required under Section 7 of the Federal Endangered Species Act (ESA).

1.2.2 Description

Flood protection components of the Project are being constructed in phases along 2.6 miles of the Guadalupe River in downtown San Jose between Interstate 880 (I-880) and Grant Avenue, which is just upstream from Interstate 280 (I-280) (figure 1-2). A section of the river between these boundaries, specifically between Woz Way and Park Avenue (in the MMP, referred to as the Woz Way to Park Avenue Bypass Reach), does not include Project flood protection construction but does include SRA cover mitigation plantings.

The proposed flood protection and recreation components of the Project include stream channel and bank armoring, underground bypass construction, bridge removal and replacement, and trail/maintenance road and stairwell construction. Mitigation components include installation of riparian vegetation and SRA cover plantings, construction of a low-flow channel in armored channel sections, and development of instream habitat through the placement of geomorphic features in the channel. All Project components are described in the *General Re-evaluation Report/Environmental Impact Report/Supplemental Environmental Impact Statement* (GRR/EIR/SEIS) (U.S. Army Corps of Engineers, 2001b).

1.2.3 Location

The Project area is divided into segments, moving downstream to upstream, as shown on figure 1-2.

- Segment 1 is located between I-880 and Hedding Street.
- Segment 2 is located between Hedding Street and Coleman Avenue.
- Segment 3 is located between Coleman Avenue and Grant Street. Segment 3 is further broken down into Segments 3A, 3B, and 3C. Segment 3A is

located between Coleman Avenue and New Julian Street. Segment 3B is located between New Julian Street and Park Avenue. Segment 3C is located between Woz Way and Grant Street.

- Woz Way to Park Avenue Bypass is located between Park Avenue and Woz Way.

Each of these segments includes mitigation components. For 2 of the mitigation components, riparian vegetation and SRA cover mitigation, the designation and area or length of each planting area in the Project area are listed in table 1-1. Mitigation in the Project area is considered onsite mitigation.

Two offsite mitigation areas are also proposed to supplement the onsite mitigation and are shown on figure 1-3.

- The Reach A offsite mitigation site is located on the Guadalupe River between Airport Parkway and I-880. Although Reach A extends farther downstream than Airport Parkway, mitigation components are located only in the section described. In the IP, Reach A refers only to this section.
- The Guadalupe Creek offsite mitigation site, located on a tributary to the Guadalupe River, is located between Almaden Expressway and Masson Dam. Although Guadalupe Creek extends farther upstream than Masson Dam, mitigation components are located only in the section described. In the IP, Guadalupe Creek refers only to this section.

Table 1-2 lists the designation and length of each SRA cover mitigation planting area in Reach A and Guadalupe Creek.

Table 1-3 compares the nomenclature used to label Project area and offsite SRA cover planting areas and sampling plots in this document with the nomenclature used in the MMP.

1.2.4 Role of Adaptive Management

Adaptive management is defined for the Project as a decision-making process to optimize the long-term implementation of flood protection measures on the Guadalupe River, with the objective of ensuring that ecological functions and habitat values affected by the Project are reestablished. Key components of adaptive management are

- identifying indicators for ecological functions and habitat values,
- monitoring the indicators,
- setting measurable objectives (numerical and descriptive goals) for the indicators, and
- planning and implementing remedial actions.

The adaptive management process provides a mechanism by which remedial actions can be implemented if a measurable objective is not achieved. The adaptive management process includes

- selection of indicators and measurable objectives during Project planning,
- measurement of indicators as part of the monitoring phase, and
- assessment to determine achievement of measurable objectives.

The IP provides the prescriptive implementation tools for assessing the performance of the mitigation as an input to the adaptive management process during the monitoring and assessment phases. The results of the monitoring program will be documented in the annual mitigation monitoring report. The Adaptive Management Team will review the report and make decisions regarding general mitigation performance, applicability of the indicators, monitoring methodology, comparison and validity of measurable objectives, and recommended remedial actions. The MMP describes the scope, procedures, and constituents of the Adaptive Management Team in more detail.

1.3 How to Use This Document

The IP has been designed for optimum accessibility, readability, and ease of use, guided by the concepts and tools described below.

1.3.1 Organization

1.3.1.1 Consistency with the MMP

Recognizing the importance of the MMP in directing the IP's content, a parallel outline has been adopted for the indicator discussion in the IP that follows the corresponding discussion sequence in the MMP. Similar terminology used in the MMP is retained in the IP unless otherwise indicated.

1.3.1.2 Parallelism in the Implementation Plan

Each chapter in the IP follows a consistent structure and format to facilitate review and use, based on monitoring components. There are 6 monitoring components: riparian vegetation, SRA cover, water temperature, anadromous fish spawning habitat, anadromous fish passage and rearing habitat, and anadromous fish occurrence. Related environmental indicators and environmental condition parameters (data collected to support indicators, but for which there is no measurable objective) are grouped under each monitoring component. For example, the anadromous fish passage and rearing habitat monitoring component covers the following indicators: depth and velocity barriers, vertical barriers, and rearing habitat diversity. In each monitoring

Table 1-1. Summary of Individual SRA Cover and Riparian Vegetation Planting Areas Located in the Onsite Mitigation Area

Page 1 of 2

Segment	Individual Mitigation Planting Area Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
SRA Cover Mitigation Planting Areas				
Segment 1	SRA PA-12	61	January 2001	
	SRA PA-13	44	January 2001	
	SRA PA-14	49	January 2001	
	SRA PA-15	13	January 2001	
	SRA PA-16	113	Fall 2002	
	SRA PA-17	21	January 2001	
	SRA PA-18	99	January 2001	
	SRA PLOT-8A	70	January 2001	
	SRA PLOT-8B	47	January 2001	
	SRA PLOT-8C	23	January 2001	
	SRA PLOT-8D	30	January 2001	
Subtotal – Segment 1		570		
Segment 2	SRA PA-19	616	January 2001	
	SRA PA-20	43	January 2001	
	SRA PA-21	172	January 2001	
	SRA PA-22	77	April 2001	
	SRA PA-23	119	Fall 2001	
	SRA PA-24	122	Fall 2001 plot 10	
	SRA PA-25	21	January 2001	
	SRA PA-26	24	January 2001	
	SRA PLOT-9A	55	January 2001	
	SRA PLOT-9B	110	January 2001	
	SRA PLOT-9C	35	January 2001	
	SRA PLOT-10	200	Fall 2001	
Subtotal – Segment 2		1,594		
Segment 3A	NA	410	Fall 2004	Information on the lengths of individual mitigation sites is not yet available.
Subtotal – Segment 3A		410		

Table 1-1. Continued

Segment	Individual Mitigation Planting Area Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
Woz Way to Park Avenue Bypass	SRA PA-27	77	Fall 2000	Formerly referred to as the "Rubble Removal Site"
	SRA PLOT-12A	58	Fall 2000	Formerly referred to as the "Auzerais Point Boulder Site"
	SRA PLOT-12B	142	Fall 1998	Formerly referred to as the "Children's Discovery Museum Site"
Subtotal – Woz Way to Park Avenue Bypass		277		
Total—SRA Cover Vegetation Mitigation Planting Length in Onsite Mitigation Area		2,851		

Segment	Individual Planting Area Designation	Planting Area Size (acres)	Date of Installation Completion	Comments
Riparian Vegetation Mitigation Planting Areas				
Segment 1	1A	1.7	Fall 1994	
	1B	2.3	Fall-spring 1998–1999	
Subtotal – Segment 1		4.0		
Segment 2	2	17.0	Fall-spring 1998–1999	
Subtotal – Segment 2		17.0		
Total—Riparian Vegetation Mitigation Acreage in Onsite Mitigation Area		21.0		

Note: NA = not applicable.

Table 1-2. Summary of Individual SRA Cover Mitigation Planting Areas in the Offsite Mitigation Areas: Reach A and Guadalupe Creek

Mitigation Area	Individual Mitigation Planting Area or Sampling Plot Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
Reach A	SRA PA-1	220	Fall 2002	
	SRA PA-2	270	April 2001	Pilot planting site 1 (300 feet long) was installed in winter 1998–1999 and are located within this mitigation site.
	SRA PA-3	151	April 2001	
	SRA PA-4	168	April 2001	
	SRA PA-5	322	April 2001	
	SRA PA-6	650	April 2001	
	SRA PA-7	1,060	April 2001	Pilot planting site 2 (250 feet long) was installed in winter 1998–1999 and are located within this mitigation site.
	SRA PA-8	1,593	April 2001	Pilot planting site 3 (300 feet long) was installed in winter 1998–1999 and are located within this mitigation site.
	SRA PA-9	1,285	April 2001	Pilot planting site 4 (300 feet long) was installed in winter 1998–1999 and is located within this mitigation site. This planting area is in a restricted planting area (reduced planting density necessary to maintain hydraulic capacity).
	SRA PA-10	257	April 2001	
	SRA PA-11	404	April 2001	Pilot planting site 5 (300 feet long) was installed in winter 1998–1999 and is located within this mitigation site. This planting area is in a restricted planting area (reduced planting density necessary to maintain hydraulic capacity).
	SRA PLOT-1	200	April 2001	
	SRA PLOT-2	200	April 2001	
	SRA PLOT-3	200	April 2001	
	SRA PLOT-4	200	April 2001	
	SRA PLOT-5	200	April 2001	

Table 1-2. Continued

Mitigation Area	Individual Mitigation Planting Area or Sampling Plot Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
	SRA PLOT-6	200	April 2001	
	SRA PLOT-7	200	April 2001	
Subtotal – Reach A		7,780		
Guadalupe Creek	SRA PA-28	261	Fall 2001	
	SRA PA-29	847	Fall 2001	
	SRA PA-30	286	Fall 2001	
	SRA PA-31	22	Fall 2001	
	SRA PA-32	107	Fall 2001	
	SRA PA-33	592	Fall 2001	
	SRA PA-34	114	Fall 2001	
	SRA PA-35	262	Fall 2001	
	SRA PA-36	514	Fall 2001	
	SRA PA-37	57	Fall 2001	
	SRA PA-38	241	Fall 2001	
	SRA PA-39	206	Fall 2001	
	SRA PA-40	164	Fall 2001	
	SRA PA-41	764	Fall 2001	
	SRA PA-42	188	Fall 2001	
	SRA PA-43	804	Fall 2001	
	SRA PA-44	202	Fall 2001	
	SRA PA-45	27	Fall 2001	
	SRA PA-46	418	Fall 2001	
	SRA PA-47	66	Fall 2001	
	SRA PA-48	291	Fall 2001	

Mitigation Area	Individual Mitigation Planting Area or Sampling Plot Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
	SRA PA-49	40	Fall 2001	
	SRA PA-50	43	Fall 2001	
	SRA PA-51	66	Fall 2001	
	SRA PA-52	464	Fall 2001	
	SRA PA-53	202	Fall 2001	
	SRA PA-54	534	Fall 2001	
	SRA PA-55	91	Fall 2001	
	SRA PA-56	25	Fall 2001	
	SRA PA-57	52	Fall 2001	
	SRA PA-58	202	Fall 2001	
	SRA PA-59	105	Fall 2001	
	SRA PA-60	121	Fall 2001	
	SRA PA-61	77	Fall 2001	
	SRA PA-62	349	Fall 2001	
	SRA PA-63	891	Fall 2001	
	SRA PA-64	99	Fall 2001	
	SRA PA-65	773	Fall 2001	
	SRA PA-66	79	Fall 2001	
	SRA PLOT-13	200	Fall 2001	
	SRA PLOT-14	200	Fall 2001	
	SRA PLOT-15	200	Fall 2001	
	SRA PLOT-16	200	Fall 2001	
	SRA PLOT-17	200	Fall 2001	
	SRA PLOT-18A	40	Fall 2001	
	SRA PLOT-18B	80	Fall 2001	

Mitigation Area	Individual Mitigation Planting Area or Sampling Plot Designation	Length of Planting Area (linear feet)	Date of Installation Completion	Comments
	SRA PLOT-18C	80	Fall 2001	
	SRA PLOT-19	200	Fall 2001	
	SRA PLOT-20	200	Fall 2001	
	SRA PLOT-21A	150	Fall 2001	
	SRA PLOT-21B	50	Fall 2001	
	SRA PLOT-22A	100	Fall 2001	
	SRA PLOT-22B	100	Fall 2001	
	SRA PLOT-23A	100	Fall 2001	
	SRA PLOT-23B	45	Fall 2001	
	SRA PLOT-23C	55	Fall 2001	
	SRA PLOT-24A	20	Fall 2001	
	SRA PLOT-24B	180	Fall 2001	
Subtotal – Guadalupe Creek		13,046		
Total – SRA Cover Vegetation Mitigation Planting Length in Offsite Mitigation Areas		20,826		

Note: NA = not applicable.

Table 1-3. Corresponding Nomenclature for SRA Cover Sampling Plots and Planting Areas in the Implementation Plan (IP) and Mitigation Monitoring Plan (MMP)

Segment	Revised Planting Area and Sampling Plot Nomenclature (used in the IP)	Planting Area and Sampling Plot Nomenclature (used in the MMP)	Comments
Reach A	SRA PA-1	RA-8	
	SRA PA-2	RA-6	
	SRA PA-3	RA-7	
	SRA PA-4	RA-3	
	SRA PA-5	RA-5	
	SRA PA-6	RA-5	
	SRA PA-7	RA-4	
	SRA PA-8	RA-3, RA-1	
	SRA PA-9	RA-4, RA-2	
	SRA PA-10	RA-2	
	SRA PA-11	RA-1	
	SRA PLOT-1	RA-6	
	SRA PLOT-2	RA-7	
	SRA PLOT-3	RA-5	
	SRA PLOT-4	RA-3	
	SRA PLOT-5	RA-4	
	SRA PLOT-6	RA-1	
	SRA PLOT-7	RA-2	
Segment 1	SRA PA-12	Site 1G	
	SRA PA-13	Site 1F	
	SRA PA-14	Site 1C	
	SRA PA-15	Site 1B	
	SRA PA-16	Site 1D	
	SRA PA-17	Site 1A	
	SRA PA-18	Site 1A	
	SRA PLOT-8A	Site 1C	
	SRA PLOT-8B	Site 1C	
	SRA PLOT-8C	Site 1B	
	SRA PLOT-8D	Site 1A	
Segment 2	SRA PA-19	Site 2H	
	SRA PA-20	Site 2F	
	SRA PA-21	NA	

Segment	Revised Planting Area and Sampling Plot Nomenclature (used in the IP)	Planting Area and Sampling Plot Nomenclature (used in the MMP)	Comments
	SRA PA-22	Site 2D	
	SRA PA-23	Site 2E	
	SRA PA-24	Site 2B	
	SRA PA-25	NA	
	SRA PA-26	Site 2A	
	SRA PLOT-9A	NA	
	SRA PLOT-9B	NA	
	SRA PLOT-9C	NA	
	SRA PLOT-10	Site 2E	
Segment 3A	NA	Sites 3A-1–10	Revised nomenclature for the planting areas and sampling plot in Segment 3A has not been determined.
Woz Way to Park Avenue Bypass	SRA PA-27	Rubble Removal Planting Site	
	SRA PLOT-12A	Auzerais Point Planting Site	
	SRA PLOT-12B	Children’s Discovery Museum Planting Site	
Guadalupe Creek	SRA PA-28	NA	Nomenclature for planting areas and sampling plots in Guadalupe Creek was not included in the MMP.
	SRA PA-29	NA	
	SRA PA-30	NA	
	SRA PA-31	NA	
	SRA PA-32	NA	
	SRA PA-33	NA	
	SRA PA-34	NA	
	SRA PA-35	NA	
	SRA PA-36	NA	
	SRA PA-37	NA	
	SRA PA-38	NA	
	SRA PA-39	NA	
	SRA PA-40	NA	
	SRA PA-41	NA	
	SRA PA-42	NA	

Segment	Revised Planting Area and Sampling Plot Nomenclature (used in the IP)	Planting Area and Sampling Plot Nomenclature (used in the MMP)	Comments
	SRA PA-43	NA	
	SRA PA-44	NA	
	SRA PA-45	NA	
	SRA PA-46	NA	
	SRA PA-47	NA	
	SRA PA-48	NA	
	SRA PA-49	NA	
	SRA PA-50	NA	
	SRA PA-51	NA	
	SRA PA-52	NA	
	SRA PA-53	NA	
	SRA PA-54	NA	
	SRA PA-55	NA	
	SRA PA-56	NA	
	SRA PA-57	NA	
	SRA PA-58	NA	
	SRA PA-59	NA	
	SRA PA-60	NA	
	SRA PA-61	NA	
	SRA PA-62	NA	
	SRA PA-63	NA	
	SRA PA-64	NA	
	SRA PA-65	NA	
	SRA PA-66	NA	
	SRA PLOT-13	NA	
	SRA PLOT-14	NA	
	SRA PLOT-15	NA	
	SRA PLOT-16	NA	
	SRA PLOT-17	NA	
	SRA PLOT-18A	NA	
	SRA PLOT-18B	NA	
	SRA PLOT-18C	NA	

Segment	Revised Planting Area and Sampling Plot Nomenclature (used in the IP)	Planting Area and Sampling Plot Nomenclature (used in the MMP)	Comments
	SRA PLOT-19	NA	
	SRA PLOT-20	NA	
	SRA PLOT-21A	NA	
	SRA PLOT-21B	NA	
	SRA PLOT-22A	NA	
	SRA PLOT-22B	NA	
	SRA PLOT-23A	NA	
	SRA PLOT-23B	NA	
	SRA PLOT-23C	NA	
	SRA PLOT-24A	NA	
	SRA PLOT-24B	NA	

Note: NA = not applicable.

component–based chapter, the following information, by indicator or environmental condition parameter, is discussed

- data collection,
- data management, and
- data analysis and evaluation.

The only exception to this format approach is chapter 6, which addresses water temperature indicators and environmental condition parameters. The format of this chapter has been modified to better explain the water temperature monitoring and evaluation process. The first part of the chapter describes data collection and processing and then introduces the JSATEMP stream temperature model (JSATEMP model) and how the processed data is used with the model. The second part of the chapter describes how to run the model to simulate Project effects on water temperature and evaluate these effects using the water temperature indicators.

1.3.2 Audience

The IP has been written for 3 distinct audiences: data collection staff, data management staff, and data analysis and evaluation staff. As a result, the level of detail and writing tone are tailored to the skill sets and backgrounds of these target audiences.

- The audience for data collection sections is assumed to have a college-level degree in a biology-related or physical sciences–related field, familiarity with ecological terms and biological monitoring techniques. The data collection text is presented in a style similar to that of a biology manual and clearly lays out all steps of the data collection process.
- The audience for data management sections is assumed to have a college-level degree in a computer science- or geography-related field and experience in managing large databases and working with geographic information systems (GIS).
- The audience for data analysis and evaluation sections is assumed to have a college-level degree in a biology-related field and, depending on the data being analyzed and evaluated, experience in biostatistical analysis and environmental modeling, specifically water temperature modeling.

1.3.3 Intent as a Living Document

The IP should be updated in response to major revisions to the MMP; based on Adaptive Management Team recommendations; or if data collection, data management, and data analysis and evaluation techniques change.

Note: Recommendations made by the Adaptive Management Team in its 2001 and 2002 mitigation monitoring reports (Jones & Stokes 2002, chapter 4; Jones & Stokes 2003, chapter 4) are incorporated in this IP. Recommendations made by the Adaptive Management Team subsequent to these reports have not been incorporated into this IP.

1.3.4 Specific Tools for Document Use

1.3.4.1 Schedule (Chapter 2)

The overall monitoring schedule is based on water years (October 1—September 30). For example, monitoring year (MY) 1 for most indicators and environmental condition parameters covers the period from October 1, 2000 to September 30, 2001 or water year (WY) 2001.

The monitoring program has been synthesized and summarized into a series of scheduling tables, which provide an at-a-glance overview of the frequency, timing, location, and professional expertise required to monitor each indicator and environmental condition parameter.

1.3.4.2 Annual Mitigation Monitoring Report Outline (Chapter 10)

To encourage use of a standardized format for the annual mitigation monitoring report that will be consistent throughout the monitoring period, a suggested outline for the report has been included. The outline satisfies the reporting requirements of the Adaptive Management Team for each indicator and facilitates discussion, analysis, and recommendations regarding the monitoring program and its performance against the measurable objectives.

1.3.4.3 Glossary (Appendix A)

To improve readability, nonessential definitions have been removed from the text and are included in a comprehensive glossary. An important definition to be aware of throughout the IP is the distinction between banks. The terms right bank and left bank are used and are relative to a person facing downstream.

1.3.4.4 Data Collection Forms (Appendix D)

For each indicator or environmental condition parameter requiring collection of field data, data collection forms have been created and closely coordinated with the data collection methods in the respective chapters. As an example, the order in which measurements are recorded in the field is reflected in the order of columns and rows of the data collection forms. Where space allowed, reference tables have been provided on the data collection form for ease of use.

1.3.4.5 Permanent Sampling Plot and Transect Locations (Appendix E)

The permanent, field-marked monitoring locations for indicators and environmental condition parameters that require consistently applied data collection sampling points (indicators for riparian vegetation, SRA cover, and channel bottom stability) are discussed and illustrated on aerial photographs in appendix E. This appendix includes criteria for selecting the sampling plots and transects.

Chapter 2
Schedule

Project implementation schedule

2.1 Introduction

Developing a schedule for implementing the MMP is complicated by several factors.

- There are multiple phases of Project construction and mitigation installation. Project construction and mitigation installation can be phased by Project segment (e.g., Segments 3B and 3C) or by parts of a Project segment (e.g., bank stabilization sites near Taylor Street Bridge in Segment 2 and Airport Parkway in Reach A).
- Monitoring is phased by Project segment or parts of a Project segment or conducted simultaneously for the entire Project area, depending on the indicator being monitored and its associated measurable objective. Some measurable objectives are applied to parts of the Project area (e.g., measurable objective for shaded stream surface area indicator), and other measurable objectives are applied to the entire Project area (e.g., measurable objective for spawning gravel abundance indicator).
- Monitoring for some indicators is triggered by the completion of Project construction, while the monitoring for other indicators is triggered by the completion of mitigation installation.
- Each indicator has a unique schedule for monitoring during and among monitoring years (e.g., the SRA cover instream cover indicator is monitored once a monitoring year between June and October immediately following Project construction and then at 3-monitoring-year intervals plus MY 10).
- As the monitoring program described in this IP evolves and data on measurable objective compliance is collected over time, the Adaptive Management Team may recommend changes to the program, which could

> directly or indirectly affect schedule. The effects of potential changes to the monitoring program should be reviewed carefully to determine how they will affect schedule, data collection, data analysis, and budget considerations.

To address the complexities of developing a schedule for implementing the MMP, a set of tables (tables 2-1–2-3) has been developed that takes the reader through each step of the scheduling process to arrive at a comprehensive schedule for all indicators by monitoring location for the first 10 calendar years of the monitoring program (table 2-3). In addition, another set of tables has been developed to identify technical staffing requirements to implement the monitoring laid out in the comprehensive schedule (tables 2-4 and 2-5).

2.2 How to Use Tables 2-1–2-5

2.2.1 Overview

Tables 2-3 and 2-5 are the main tables to which managers of the monitoring program will likely refer. Table 2-3 is the comprehensive schedule for the monitoring program, and table 2-5 lists the technical staffing requirements necessary to implement the monitoring program according to the schedule identified in table 2-3. Tables 2-1, 2-2, and 2-4 provide background information that was used to build tables 2-3 and 2-5, and the information contained within them may be necessary to make changes in tables 2-3 and 2-5, as circumstances change. The rationale behind each table and their relationship to each other are described below.

2.2.2 Table 2-1 (Schedule for Indicator Monitoring by Month and Monitoring Year through Monitoring Year 10)

Table 2-1 shows the monitoring schedule for each indicator by month and monitoring year for the first 10 calendar years of the monitoring program; it also shows whether the measurable objective for each indicator needs to be met during this same time period. This information is based on the MMP and subsequent Adaptive Management Team–related recommendations. To convert this information into a schedule for the monitoring program, it is necessary to determine what triggers the indicator that is being monitored—Project construction or mitigation installation. This step is important because the phasing for Project construction and mitigation installation are sometimes different and, as such, affect the phasing of the indicator monitoring schedule. Table 2-2 has been developed to identify indicator monitoring triggers and address effects of Project construction and mitigation installation phasing on schedule.

Table 2-1. Schedule for Indicator Monitoring by Month and Monitoring Year through Monitoring Year 10

Page 1 of 2

Indicator	Month Of Monitoring[a]												Preproject[b]			Year Of Monitoring[c]										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	3	RA	GC	0[d]	1	2	3	4	5	6	7	8	9	10
Riparian Vegetation																										
Survival								1	░								M	M	M	M[e]						
Health and vigor								1	░								M	M	M	M	M					
Qualitative assessment								1	░								░	░	░	░	░					
Natural recruitment								1	░												M					
Native vegetative cover								1	░											░	░					░
Nonnative vegetative cover								1	░								M	M	M	M	M					M
Tree height								1	░												░					░
Tree basal area								1	░												░					░
SRA Cover																										
Survival								1	░								M	M	M	M[e]						
Health and vigor								1	░								M	M	M	M	M					
Qualitative assessment								1	░								░	░	░	░	░					
Natural recruitment								1	░												M					
Nonnative vegetative cover								1	░								M	M	M	M	M					M
Shaded stream surface									1	░						░			░			░			░	
Bank stability				1	░	░											M	M	M	M			M			M
Instream cover						1[f]	░	░	░	░						░			░			░			░	M
Channel bottom stability				1	░	░	░	░	░	░			░		░	░	M	M	M	M	M	M	M	M	M	M
Water Temperature[g]																										
Measured water temperature[h]	■	■	■	Hourly	░	░	░	░	░	░	■	■	░	░	░	░	░	░	░	░	░	░	░	░	░	░
Solar heat transfer[i]					▩	▩	▩	▩	▩	▨			░	░	░	░			▩	▨	▨	▩	▨	▨	▩	▨
Stream channel geometry						1	░	░	░				░	░	░	░					░					░
Stream flow				1	1	1	1	1	1	1			░	░	░	░			░	░	░					░
Simulated water temperature	1	1	1	1	1	1	1	1	1	1	1	1				░	░	░	░	░	░	░	░	░	░	░
Monthly thermal suitability	1	░	░														░	░	░	░	░	░	░	░	░	░

Table 2-1. Continued

Indicator	Month Of Monitoring[a]												Preproject[b]			Year Of Monitoring[c]										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	3	RA	GC	0[d]	1	2	3	4	5	6	7	8	9	10
Short-term thermal suitability																										
Anadromous Fish Spawning Habitat																										
Spawning gravel abundance						1	▨	▨	▨	▨				▨	▨		M	M	M	M	M					▨
Spawning gravel quality						1	▨	▨	▨	▨				▨	▨		M	M	M	M	M					▨
Anadromous Fish Passage and Rearing Habitat																										
Depth and velocity	2	2	2	1						2	2	2					M	M	M	M	M	M	M	M	M	M
Vertical barrier	2	2	2	1						2	2	2					M	M	M	M	M	M	M	M	M	M
Rearing habitat diversity						1	▨	▨	▨				▨	▨	▨		M	M	M	M	M					
Anadromous Fish Occurrence																										
Adult migration and spawning		2	2	1						2	2		▨	▨	▨		M	M	M	M	M	M	M	M	M	M
Juvenile rearing									1	▨			▨	▨	▨		M	M	M	M	M	M	M	M	M	M

Notes:

[a] Number indicates repetition of monitoring activity during the shaded period.

[b] 3=Segments 3A and 3B; RA=Reach A; GC=Guadalupe Creek.

[c] M indicates that the measurable objective must be met in that monitoring year.

[d] Monitoring activities are to be conducted immediately after mitigation installation or Project construction.

[e] Survival will be monitored in monitoring year 4 in those sampling plots in which willows with an undetermined growth form were present in monitoring year 3.

[f] Coordinate with Santa Clara Valley Water District's Water Operations Group regarding flow regulation.

[g] Measured water temperature data are used for JSATEMP stream temperature model calibration and confirmation. Heat transfer, stream channel geometry, and stream flow data are used for JSATEMP model simulations.

[h] From November 1 to March 31, hourly water temperature will continue to be recorded continuously at 2 locations if stream flows are sufficiently low to allow water temperature data loggers to remain in place.

[i] Solar heat transfer monitoring has 3 components, 1 of which has a slightly different schedule than the other 2. Solar radiation and shade area will be monitored once a year in May—September prior to Project construction and for monitoring years 0, 3, 6, and 9 (gray shading). Aquatic vegetation growth will be monitored monthly in April–October each monitoring year until an annual growth pattern is established or until aquatic vegetation is shaded out by riparian vegetation (diagonal lines). See section 6.2.2.3 for a more detailed discussion of the solar heat transfer monitoring schedule.

Table 2-2. Monitoring Year Determination for Monitoring Locations Based on Project Construction or Mitigation Installation Completion Date

			Project Construction		Mitigation Installation		
Monitoring Component	Indicators to Be Monitored [a]	Monitoring Location	Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	Comments
Riparian Vegetation	Survival (M), health and vigor (M), natural recruitment (M), tree height (M), tree basal area (M)	**Riparian Sampling Plots (RIP)**					
		RIP-1–10, 12–18 (Segments 1B and 2)	NA	NA	Fall–spring 1998/1999	6	
		RIP-11 (Segment 2)	NA	NA	Fall–winter 2001/2002	3	Sampling plot RIP-11 was replanted in fall–winter 2001/2002 after U.S. Army Corps of Engineers (Corps) bank stabilization work in the area was completed.
		RIP-19 and 20 (Segment 1A)	NA	NA	Fall 1994	10[c]	
	Tree basal area (M)	**Basal Area Reference Plots**					
			NA	NA	NA	NA	Between 5 and 10 basal area reference plots will be established in stands of mature riparian forest.
	Native vegetative cover (M), nonnative vegetative cover (M)	**Riparian Line Transects (RIP-T)**					
		RIP-T3–12 (Segment 1A)	NA	NA	Fall 1994	10[c]	Line transects RIP-T3–12 were planted in 2 different years. Portions of the transects to the west of the secondary channel were planted in 1994. Portions of transects to the east of the secondary channel were planted in 1998/1999.
		RIP-T3–12 (Segment 1B)	NA	NA	Fall–spring 1998/1999	6	
		RIP-T30 (Segment 2)	NA	NA	Fall–winter 2001/2002	3	
		RIP-T31–34 (Segment 2, west of secondary channel)	NA	NA	Fall–spring 1998/1999	6	Line transects RIP-T31–34 were planted in 2 different years. Portions of the transects to the west of the secondary channel were planted in 1998/1999. Portions of transects to the east of the secondary channel were planted in 2001/2002 after Corps bank stabilization work in the area was completed.
		RIP-T31–34 (Segment 2, east of secondary channel)	NA	NA	Fall–winter 2001/2002	3	
		RIP-T1, 2, 13–29, 35–50 (Segments 1B and 2)	NA	NA	Fall–spring 1998/1999	6	

Monitoring Component	Indicators to Be Monitored [a]	Monitoring Location	Project Construction		Mitigation Installation		Comments
			Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	
	Qualitative assessment (M), nonnative vegetative cover (M)	**Entire Riparian Vegetation Mitigation Planting Area**					
		Segment 1A	NA	NA	Fall 1994	10[c]	
		Segment 1B	NA	NA	Fall–spring 1998/1999	6	
		Segment 2	NA	NA	Fall–spring 1998/1999	6	Area in Segment 2 south of Taylor Street Bridge and east of the secondary channel between line transects RIP-T31 and RIPT-35 was replanted in fall–winter 2001/ 2002 when Corps bank stabilization work was completed.
		Segment 2 (area south of Taylor Street Bridge)	NA	NA	Fall–winter 2001/2002	3	
SRA Cover	Survival (M), health and vigor (M), natural recruitment (M), shaded stream surface (M)	**SRA Cover Sampling Plots (SRA)**					
		SRA-1, 3–5 (Reach A)	NA	NA	April 2001	4	Because these sampling plots had 5 months to grow between installation and monitoring, year 1 monitoring was conducted in same year that the plots were installed.
		SRA-2 (Reach A)	NA	NA	Winter 1998/1999	6	Sampling plot SRA-2 is a pilot planting site installed in winter 1998/1999.
		SRA-6 and 7 (Reach A – restricted zone)	NA	NA	April 2001	4	Because these sampling plots had 5 months to grow between installation and monitoring, year 1 monitoring was conducted in the same year as plots were installed.
		SRA-8 (Segment 1)	NA	NA	January 2001	4	
		SRA-9 (Segment 2)	NA	NA	January 2001	4	
		SRA-10 (Segment 2)	NA	NA	Fall–winter 2001/2002	3	Sampling plot SRA-10 was replanted in fall–winter 2001/2002 after Corps bank stabilization work in the area was completed.
		SRA-11 (Segment 3A)	NA	NA	Fall 2004	PP	

Monitoring Component	Indicators to Be Monitored [a]	Monitoring Location	Project Construction		Mitigation Installation		Comments
			Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	
		SRA-12A (Woz Way to Park Avenue Bypass)	NA	NA	Fall 2000	4	
		SRA-12B (Woz Way to Park Avenue Bypass)	NA	NA	Fall 1998	6	
		SRA-13–24 (Guadalupe Creek)	NA	NA	Spring 2002	3	
	Qualitative assessment (M), nonnative vegetative cover (M), instream cover (P), bank stability (P)	**Entire SRA Cover Mitigation Planting Area**					
		Reach A (pilot planting sites)	NA	NA[d]	Winter 1998/1999	6	Pilot planting sites in Reach A (SRA cover planting areas SRA PA-2, 7, 8, 9, and 11 and SRA cover sampling plot SRA-2) were installed in winter 1998/1999.
		Reach A (main mitigation plantings)	NA	NA[d]	January and April 2001	4	
		Reach A (bank stabilization site)	NA	NA[d]	Fall–winter 2002/2003	2	Bank stabilization work was completed in fall 2002 at the downstream end of Reach A. Planting of the stabilization site (SRA cover planting area SRA PA-01) also occurred in fall 2002.
		Segment 1 (main mitigation plantings)	1994	10[e]	January and April 2001	4	
		Segment 1 (bank stabilization site)	1994	10[e]	Fall–winter 2002/2003	2	Bank stabilization work was completed in fall 2002 at the upstream end of Segment 1. Planting of the stabilization site (SRA cover planting area SRA PA-16) also occurred in fall 2002.
		Segment 2 (main mitigation plantings)	1996	8[e]	January and April 2001	4	
		Segment 2 (bank stabilization site)	1996	8[e]	Fall–winter 2001/2002	3	Sampling plot SRA-10 and planting area SRA PA-23 were replanted in fall–winter 2001/2002 after Corps bank stabilization work in the area was completed.

Table 2-2. Continued

			Project Construction		Mitigation Installation		
Monitoring Component	Indicators to Be Monitored [a]	Monitoring Location	Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	Comments
		Segment 3A	2004	CONS	Fall 2004	CONS	
		Segment 3B	2004	CONS	NA	NA	
		Woz Way to Park Avenue Bypass	NA	NA[d]	Fall 1998	6	Sampling plot SRA-12B was planted in fall 1998.
		Woz Way to Park Avenue Bypass	NA	NA[d]	Fall 2000	4	Planting area SRA PA-27 and sampling plot SRA-12A were planted in fall 2000.
		Segment 3C	2002	2	NA	NA	
		Guadalupe Creek	NA	NA[d]	Spring 2002	3	
	Channel bottom stability (P)	**Channel Bottom Stability Transects (CT)**					
		CT-1–5 (Segment 2)	1996	8	NA	NA	
		CT-6–10 (Segment 3B)	2004	CONS	NA	NA	
		CT-11–13 (Woz Way to Park Avenue Bypass)	2002	2	NA	NA	Channel bottom stability transects in the Woz Way to Park Avenue Bypass measure the effects of Project construction in Segment 3C. Monitoring schedule for these transects is based on the Segment 3C construction completion date.
Water Temperature	Measured water temperature (P), solar heat transfer (P), stream channel geometry (P), stream flow (P)	**Entire Project Area**[f]					
		Reach A (Temperature model segment 38)	NA	NA	Winter 1998/1999, January and April 2001, fall–winter 2002/2003	6, 4, 2	Bank stabilization work was completed in fall 2002 at the downstream end of Reach A. Planting of the stabilization site also occurred in fall 2002.
		Segment 1 (Temperature model segment 37)	1994	10	January and April 2001, fall–winter 2002/2003	4, 2	Bank stabilization work was completed in fall 2002 at the upstream end of Segment 1. Planting of the stabilization site also occurred in fall 2002.

Monitoring Component	Indicators to Be Monitored [a]	Monitoring Location	Project Construction		Mitigation Installation		Comments
			Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	
		Segment 2 (Temperature model segments 35 and 36)	1996	8	January and April 2001, fall-winter 2001/2002	4, 3	
		Segment 3A (Temperature model segment 34)	2004	CONS	Fall 2004	CONS	
		Segment 3B (Temperature model segments 32 and 33)	2004	CONS	NA	NA	
		Woz Way to Park Avenue Bypass (Temperature model segment 31)	NA	NA	Fall 1998, fall 2000	6, 4	
		Segment 3C (Temperature model segment 30)	2002	2	NA	NA	
		Guadalupe Creek (Temperature model segments 5 and 6)	NA	NA	Spring 2002	3	
Anadromous Fish	Spawning gravel abundance (P), spawning gravel quality (P), depth and velocity (P), vertical barrier (P), rearing habitat diversity (P), adult migration and spawning (P)	**Entire Project Area**					
		Reach A	NA	NA[d]	Winter 1998/1999, January and April 2001, fall–winter 2002/2003	6, 4, 2	Bank stabilization work was completed in fall 2002 at the downstream end of Reach A. Planting of the stabilization site also occurred in fall 2002.
		Segment 1	1994	10[e]	NA	NA	
		Segment 2	1996	8[e]	NA	NA	
		Segment 3A	2004	CONS	NA	NA	

Table 2-2. Continued

Monitoring Component	Indicators to Be Monitored[a]	Monitoring Location	Project Construction		Mitigation Installation		Comments
			Completion Date	Monitoring Year in Water Year 2004[b]	Completion Date	Monitoring Year in Water Year 2004[b]	
		Segment 3B	2004	CONS	NA	NA	
		Segment 3C	2002	2	NA	NA	
		Woz Way to Park Avenue Bypass	NA	NA[d]	Fall 1998, fall 2000	6, 4	
		Guadalupe Creek	NA	NA[d]	Spring 2002	3	
	Juvenile rearing (P)	**Juvenile Rearing Monitoring Locations**					
		12 locations (Reach A, Segments 1–3, Woz Way to Park Avenue Bypass)	NA, 1994, 1996, 2004, 2004, 2003, NA	NA, 10, 8, CONS, CONS, 1, NA	NA	NA	
		8 locations (Guadalupe Creek)	Fall 2001	3	NA	NA	
		Variable		NA			

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[a] (M) = monitoring of this indicator is triggered by date of mitigation installation.
(P) = monitoring of this indicator is triggered by date of Project construction.

[b] Monitoring year abbreviations are as follows:

PP = preproject; prior to Project construction or mitigation installation.
CONS = construction; Project construction or mitigation installation are in process.
0 = postconstruction; immediately following Project construction or mitigation installation.
1–10 = monitoring years 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10; the first through tenth monitoring year following Project construction or mitigation installation.
NA = not applicable; no Project construction or mitigation installation occurred in this area.

[c] In water year 2001, monitoring year 5 data were collected for Segment 1A, even though it was in calendar year 7, so that data could be gathered for the plot (rather than waiting 3 more years before any data were gathered).

[d] No Project construction was conducted in Reach A and Woz Way to Park Avenue Bypass that would determine in which monitoring year they fell. Therefore, Reach A and Woz Way to Park Avenue Bypass were assumed to be in monitoring year 1 in water year 2001 for the instream cover, bank stability, spawning gravel abundance, spawning gravel quality, depth and velocity and vertical barrier, rearing habitat diversity, and adult migration and spawning indicators because water year 2001 was the first year in which data were collected for these indicators. No Project construction occurred in Guadalupe Creek; however Guadalupe Creek was assumed to be in monitoring year 1 in water year 2002 for the above indicators because restoration construction in Guadalupe Creek was completed in spring 2002.

[e] Segments 1 and 2 were assumed to be in monitoring year 1 in water year 2001 for the instream cover, bank stability, and rearing habitat diversity indicators, so that the full schedule of monitoring for these indicators could be conducted. Monitoring for the instream cover and bank stability indicators is scheduled to occur through monitoring year 10, and monitoring for the rearing habitat diversity indicator is scheduled to occur through monitoring year 5 (table 2-1). Because Segments 1 and 2 were constructed in 1994 and 1996, respectively, and because no monitoring for these indicators was conducted prior to water year 2001, most of the scheduled monitoring for these indicators would be skipped if these locations were considered to be in monitoring years 7 and 5, respectively.

[f] Refer to chapter 6 for descriptions of the temperature model segments and to table 6-1 for their upstream and downstream limits. Temperature model segments do not correlate exactly with stream segments (e.g., the downstream limit for Segment 3B is New Julian Street, while the downstream limit for temperature model segment 33 is Old Julian Street).

Table 2-3. Schedule for Indicator Monitoring by Monitoring Location and Water Year

Indicator	Data Location Type	Locations By Water Year[a]									
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Riparian Vegetation											
Survival	20 riparian sampling plots (RIP), 50 riparian line transects (RIP-T), and 5–10 basal area reference plots in Segments 1A, 1B, and 2 or entire riparian vegetation mitigation planting area in Segments 1A, 1B, and 2	RIP 1–10, 13-18	RIP 11	RIP 11	RIP 11	RIP 11[b]					
Health and vigor		RIP 1–10, 13-20	RIP 1–18	RIP 1-18	RIP 11	RIP 11	RIP 11				
Qualitative assessment		Segments 1A, 1B, 2	Segments 1B, 2	Segments 1B, 2	Segment 2	Segment 2	Segment 2				
Natural recruitment		RIP 19, 20		RIP 1–10, 12-18			RIP 11				
Native vegetative cover		RIP T 3–12	RIP T 1–29, 31–50	RIP T 1–29, 31-50	RIP T 3–12	RIP T 30–34	RIP T 30-34		RIP T 1–29, 31-50		RIP T 3–12
Nonnative vegetative cover		Segments 1A, 1B, 2	Segments 1A, 1B, 2	Segments 1B, 2	Segments 1A, 2	Segment 2	Segment 2		Segment 1B, 2		Segment 1A
Tree height		RIP 19, 20		RIP 1–10, 12–18	RIP 19, 20		RIP 11		RIP 1–-10, 12–18	RIP 19, 20	
Tree basal area		RIP 19, 20		RIP 1–10, 12–18	RIP 19, 20; Basal area reference plots		RIP 11; Basal area reference plots		RIP 1–10, 12–18; Basal area reference plots	RIP 19, 20; Basal area reference plots	
SRA Cover											
Survival	25 SRA cover sampling plots (SRA): 1 in Segment 1, 2 in Segment 2, 2 in Segment 3, 7 in Reach A, 1 in the Woz Way to Park Avenue Bypass, and 12 in Guadalupe Creek or entire SRA cover mitigation	SRA 1–9, 12	SRA 1, 3–10, 12–24	SRA 1, 3–10, 12–24	SRA 10, 13–24; SRA 1, 3–9, 12A[b]	SRA 11; SRA 10, 13–24[b]	SRA 11	SRA 11	SRA 11[b]		

Table 2-3. Continued

		Locations By Water Year[a]									
Indicator	Data Location Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
	planting area in Reach A, Segments 1, 2, and 3A, and Woz Way to Park Avenue Bypass										
Health and vigor		SRA 1–9, 12	SRA 1–10, 12–24	SRA 1–10, 12–24	SRA 1, 3–10, 12–24	SRA 1, 3–24	SRA 10, 11, 13–24	SRA 11	SRA 11	SRA 11	
Qualitative assessment		Reach A, Segments 1, 2, Woz	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, Guad Creek	Reach A, Segments 1, 3A	Segment 3A	Segment 3A	
Natural recruitment				SRA 2, 12B		SRA 1, 3–9, 12A	SRA 10, 13-24			SRA 11	
Nonnative vegetative cover		Reach A, Segments 1, 2, Woz	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, Guad Creek	Reach A, Segments 1, 3A	Segment 3A, Woz	Reach A, Segment 3A	Reach A, Segments 1, 2, Woz
Shaded stream surface[c]		*SRA 1, 3–9, 12A* SRA 2, 12B	*SRA 10, 13–24*	SRA 1, 3–9, 12A	SRA 2, 10, 12B, 13–24	*SRA 11*	SRA 1, 3–9, 12A	SRA 2, 10, 11, 12B, 13–24		SRA 1, 3–9, 12A	SRA 2, 10, 11, 12B, 13–24
Bank stability		SRA 1–9, 12	Segments 1, 2, Woz, Guad Creek SRA 1–10, 12–24	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, 3B, Woz, Guad Creek	Reach A, Segments 1, 3A, 3B	Reach A, Segments 1, 2, 3A, 3B, Woz	Segments 2, 3A, 3B, Woz, Guad Creek	Reach A, Segment 1	Reach A, Segments 1, 2, Woz
Instream cover[c]	100 randomly selected transects in Segments 1–3, Reach A, and Guadalupe Creek	*Reach A, Segments 1, 2, Woz*	Segment 2, *Guad Creek*	Reach A, Segment 1, Woz	Segment 1, *Segment 3C,* Guad Creek	Segment 2 *Segments 3A, 3B*	Reach A, Segments 2, 3C, Woz	Segments 3A, 3B, Guad Creek		Reach A, Segment 3C, Woz	Segments 3A, 3B, Guad Creek

Table 2-3. Continued

		Locations By Water Year[a]									
Indicator	Data Location Type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Channel bottom stability[c, d]	13 channel bottom stability transects in Segments 2 and 3B and Woz Way to Park Avenue Bypass	Segment 2, Segment 3B, Woz	Segment 2	Segment 2, *Woz*	Segment 2, *Segment 3B*, Woz	Segments 2, 3B, Woz	Segments 2, 3B, Woz	Segment 3B, Woz	Segment 3B, Woz	Segment 3B, Woz	Segment 3B, Woz
Water Temperature[e]											
Measured water temperature [f]	15 water temperature logger locations	all	all	all	all	all	all	all	all	all	all
Heat transfer[c, d, f]	Randomly selected shady areas in Segments 1–3, Reach A, and Guadalupe Creek 3 aquatic vegetation cover transects in Guadalupe Creek	Reach A, Segments 1, 2, Segments 3A, 3B, Woz	*Guad Creek*	See note g Guad Creek aquatic vegetation cover transects	*all* Guad Creek aquatic vegetation cover transects[h]	Guad Creek aquatic vegetation cover transects[h]	Guad Creek aquatic vegetation cover transects[h]	all Guad Creek aquatic vegetation cover transects[h]	Guad Creek aquatic vegetation cover transects[h]	Guad Creek aquatic vegetation cover transects[h]	all Guad Creek aquatic vegetation cover transects[h]
Stream channel geometry[c,d, f]	Cross sections in Segments 1–3, Reach A, Guadalupe Creek (1 every 100 feet)	Reach A, Segments 1, 2, Segments 3A, 3B, 3C, Woz	*Reach A[i], Segments 1[i], 2[i], Guad Creek*	*Segment 3C*		*all*					all
Stream flow[c, d, f]	13 cross sections in Segments 1–3, Reach A, Guadalupe Creek, representing corresponding JSATEMP model segments, 7 monthly and 3 periodic cross sections[j]	Reach A, Segments 1, 2, Segments 3A, 3B, 3C Woz	*Reach A, Segments 1, 2,Guad Creek*	*Segment 3C*, all monthly and periodic cross sections	all monthly and periodic cross sections	all cross sections associated with stream channel geometry monitoring and all monthly and periodic cross sections					all cross sections associated with stream channel geometry monitoring

Indicator	Data Location Type	Locations By Water Year[a]									
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Anadromous Fish Spawning Habitat											
Spawning gravel abundance	All areas of Segments 1–3, Reach A, and Guadalupe Creek	Reach A, Segments 1, 2, 3A, 3B, Woz	Reach A, Segments 1, 2, 3A, Woz, Guad Creek	Reach A, Segments 1, 2, 3C, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, 3C, Woz, Guad Creek	all	all	Segments 1–3, Woz, Guad Creek	Segments 1–3, Woz	Segments 1–3, Woz	
Spawning gravel quality	All areas of Segments 1–3, Reach A, and Guadalupe Creek Selected sites on Los Gatos Creek and the Guadalupe River upstream of the Project area	Reach A, Segments 1, 2, 3A, 3B, Woz	Reach A, Segments 1, 2, 3A, Woz, Guad Creek	Reach A, Segments 1, 2, 3C, Woz, Guad Creek, Los Gatos, Upper Guad	Reach A, Segments 1, 2, 3A, 3C, Woz, Guad Creek, Los Gatos, Upper Guad	all	all	Segments 1–3, Woz, Guad Creek, Los Gatos, Upper Guad	Segments 1–3, Woz, Los Gatos, Upper Guad	Segments 1–3, Woz, Los Gatos, Upper Guad	
Anadromous Fish Passage and Rearing Habitat											
Depth and velocity	All areas of Segments 1–3, Reach A, and Guadalupe Creek	all	all	all	all	all	all	all	all	all	all
Vertical barrier		all	all	all	all	all	all	all	all	all	all
Rearing habitat diversity[c]		Reach A, Segments 1, 2, Woz, Segments 3A, 3B, 3C	Reach A, Segments 1, 2, Woz, Guad Creek	Reach A, Segments 1, 2, 3C, Woz, Guad Creek	Reach A, Segments 1, 2, 3C, Woz Guad Creek	Reach A, Segments 1, 2, 3A, 3B, 3C, Woz, Guad Creek	Reach A, Segments 3A, 3B, 3C, Guad Creek	Segments 3A, 3B, 3C, Guad Creek	Segments 3A, 3B	Segments 3A, 3B	

Table 2-3. Continued

Indicator	Data Location Type	Locations By Water Year[a]									
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Anadromous Fish Occurrence											
Adult migration and spawning	All areas of Segments 1–3, Reach A, and Guadalupe Creek; known and likely spawning habitat in Los Gatos Creek, Alamitos Creek, Calero Creek, Guadalupe Creek upstream of Masson Dam and Guadalupe River upstream of the Project area	Reach A, Segments 1, 2, 3A, 3B, 3C, Woz, Guad Creek	Reach A, Segments 1, 2, 3A, 3B, 3C, Woz, Guad Creek	all	all	all	all	all	all	all	all
Juvenile rearing	17 locations: 9 in Segments 1–3, 4 in Reach A, and 4 in Guadalupe Creek	all	all	all	all	all	all	all	all	all	all

[a] Monitoring location abbreviations are as follows:

Woz = Woz Way to Park Avenue Bypass.
Guad Creek = Guadalupe Creek.
Los Gatos = Los Gatos Creek.
Upper Guad = Guadalupe River upstream of the Project area.
All = all monitoring locations associated with the indicator to be monitored.

[b] Survival will be monitored in monitoring year 4 in those sampling plots in which willows with an undetermined growth form were present in monitoring year 3.

[c] Italicized monitoring locations indicate that year 0 monitoring (monitoring conducted immediately following construction) will be conducted in that location during the water year.

[d] Underlined monitoring locations indicate that preproject monitoring will be conducted in that location during the water year.

[e] Simulated water temperature, monthly thermal suitability, and short-term thermal suitability indicators are outputs from the JSATEMP stream temperature model and do not require specific data collection. Water temperature data are collected by temperature model segment. See table 6-1 for the relationship between Project segments and temperature model segments.

[f] Although measured water temperature, stream channel geometry, solar heat transfer, and stream flow are not indicators, they are included here as data to be collected as an input to the JSATEMP stream temperature model.

[g] The heat transfer indicator is not monitored in WY 2003. However, the aerial photograph taken of Guadalupe River in WY 2003 should be used to update shade assumptions for Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass.

[h] Aquatic vegetation growth will be monitored each monitoring year until an annual growth pattern is established or until aquatic vegetation is shaded out by riparian vegetation.

[i] Monitor only the cross sections located in parts of Reach A, Segment 1, and Segment 2 where bank stabilization work was conducted.

[j] Stream flow monitoring at the 7 monthly and 3 periodic cross sections may continue beyond monitoring year 5, at the discretion of the AMT.

Table 2-4. Estimated Data Collection Hours by Indicator and Unit Type

Indicator	Unit Type	Hours Per Unit Monitoring Years 1–5[a]	Hours Per Unit Monitoring Years 6–40[b]
Riparian Vegetation			
Survival[c]	Plot	1.5	NA
Health and vigor (monitoring years 1–3)[c]	Plot	1.5	NA
Health and vigor (monitoring years 4 and 5)	Plot	3.0	NA
Qualitative assessment[d]	Segment 1A	1.0	NA
	Segment 1B	1.0	NA
	Segment 2	4.0	NA
Natural recruitment	Plot	2.0	NA
Native and nonnative vegetative cover (line intercept method)	Transect	1.4	2.1
Nonnative vegetative cover (visual estimation method)[d]	Segment 1A	1.0	NA
	Segment 1B	1.2	NA
	Segment 2	5.0	NA
Native and nonnative vegetative cover (aerial photograph method)	Segment 1A	NA	4.0
	Segment 1B	NA	5.0
	Segment 2	NA	16.0
Tree height	Plot	2.0	3.0
Tree basal area	Plot	2.0	3.0
Tree basal area	Reference plot	2.0	2.0
SRA Cover			
Survival[c]	Plot	2.0	NA
Health and vigor (monitoring years 1–3)[c]	Plot	2.0	NA
Health and vigor (monitoring years 4 and 5)	Plot	4.0	NA
Qualitative assessment[d]	Reach A	4.5	NA
	Segment 1	0.5	NA
	Segment 2	1.0	NA
	Segment 3A	1.0	NA
	Woz Way	0.5	NA
	Guadalupe Creek	7.0	NA
Natural recruitment	Plot	3.0	NA
Nonnative vegetative cover (visual estimation method)[d]	Reach A	4.5	NA
	Segment 1	0.3	NA
	Segment 2	0.7	NA
	Segment 3A	1.5	NA
	Woz Way	0.3	NA
	Guadalupe Creek	7.0	NA
Nonnative vegetative cover (aerial photo method)	Reach A	NA	20.3
	Segment 1	NA	1.5

Indicator	Unit Type	Hours Per Unit Monitoring Years 1–5[a]	Hours Per Unit Monitoring Years 6–40[b]
	Segment 2	NA	3.0
	Segment 3A	NA	2.3
	Woz Way	NA	1.5
	Guadalupe Creek	NA	31.5
Shaded stream surface	Plot	2.0	3.0
Bank stability	Reach A	32.0	32.0
	Segment 1	5.0	5.0
	Segment 2	18.8	18.8
	Segment 3A	7.4	7.4
	Segment 3B	5.3	5.3
	Segment 3C	0.5	0.5
	Woz Way	8.9	8.9
	Guadalupe Creek	42.2	42.2
Instream cover	Transect	2.0	2.0
Channel bottom stability	Transect	10.0	10.0
Water Temperature			
Measured water temperature	All loggers	150.0	150.0
Solar heat transfer	Model segment	16.0	16.0
	3 aquatic vegetation growth line transects per month	2.0	42.0
Stream channel geometry	Reach A	76.0	76.0
	Segment 1	18.0	18.0
	Segment 2	48.0	48.0
	Segment 3A	26.0	26.0
	Segment 3B	36.0	36.0
	Segment 3C	8.0	8.0
	Woz Way	20.0	20.0
	Guadalupe Creek	100.0	100.0
Stream flow	Model segment visit	3.0	3.0
Anadromous Fish Spawning Habitat			
Spawning gravel abundance[e]	Reach A	17.0	17.0
	Segment 1	4.0	4.0
	Segment 2	11.0	11.0
	Segment 3A	6.0	6.0
	Segment 3B	8.0	8.0
	Segment 3C	3.0	3.0
	Woz Way	5.0	5.0

Table 2-4. Continued

Indicator	Unit Type	Hours Per Unit Monitoring Years 1–5[a]	Hours Per Unit Monitoring Years 6–40[b]
	Guadalupe Creek	22.0	22.0
Spawning gravel quality[e]	Reach A	17.0	17.0
	Segment 1	4.0	4.0
	Segment 2	11.0	11.0
	Segment 3A	6.0	6.0
	Segment 3B	8.0	8.0
	Segment 3C	3.0	3.0
	Woz Way	5.0	5.0
	Guadalupe Creek	22.0	22.0
Anadromous Fish Passage and Rearing Habitat			
Depth and velocity[f]	Monitoring action	24.0	24.0
Vertical barrier[f]			
Rearing habitat diversity	Reach A	44.0	44.0
	Segment 1	10.0	10.0
	Segment 2	28.0	28.0
	Segment 3A	15.0	15.0
	Segment 3B	21.0	21.0
	Segment 3C	9.0	9.0
	Woz Way	12.0	12.0
	Guadalupe Creek	58.0	58.0
Anadromous Fish Occurrence			
Adult migration and spawning[f]	Monitoring action	32.0	32.0
Juvenile rearing	Monitoring action (1/year)	675.0	675.0

Note: NA = not applicable; this indicator is not monitored during these monitoring years.

[a] Total time, which equals time spent monitoring times the number of people conducting the monitoring. It is assumed that 2-person teams are conducting the monitoring for all indicators but rearing habitat diversity. It is assumed that a 3-person team is collecting data for the rearing habitat diversity indicator. The time required for travel and preparation prior to monitoring (e.g., acquisition of equipment, making of travel arrangements, review of methods) is not included in this table.

[b] Data collection hours in the monitoring years 6–40 column are 1.5 times longer than data collection hours in the monitoring years 1–5 column for some riparian and SRA cover indicators because it is expected that as vegetation becomes denser, these indicators will take longer to monitor.

[c] Data collection hours assume that survival and health and vigor data are collected simultaneously in monitoring years 1–3.

[d] Data collection hours assume that qualitative assessment and nonnative vegetative cover data are collected simultaneously in monitoring years 1–5.

[e] Data collection hours assume that spawning gravel abundance and spawning gravel quality data are collected simultaneously.

[f] Data collection hours assume that adult migration and spawning and depth and velocity and vertical barrier data are collected simultaneously.

Table 2-5. Estimate of Annual Hours by Monitoring Indicator and Professional Expertise

1 of 3

Indicator And Activity		Professional Expertise	Hours By Calendar Year[a]									
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Riparian Vegetation												
Data Collection												
	Survival	Botanist	26	2	2	2						
	Health and vigor		32	53	53	2	3	3				
	Qualitative assessment		6	5	5	4	4	4				
	Natural recruitment		4		34			2				
	Native vegetative cover		7	34	34	13	4	4		62		2
	Nonnative vegetative cover		14	41	41	13	9	9		62		2
	Tree height		4		51	6		2		51	6	
	Tree basal area[b]		4		51	26		22		71	26	
Data Management[c]		Data entry specialist[d]	50	50	60	20	20	10		40	10	10
Data Analysis and Report Preparation[e]		Senior botanist	150	200	360	310	120	240		410	60	80
SRA Cover												
Data Collection												
	Survival	Botanist	20	44	44	26	2	2	2			
	Health and vigor		20	46	48	64	90	54	2	4	4	
	Qualitative assessment		7	14	14	14	15	14	6	1	1	
	Natural recruitment				6		27	39			3	
	Nonnative vegetative cover		6	13	13	13	13	13	5	2	21	26
	Shaded stream surface	Fish biologist	22	26	18	32	2	27	47		27	48
	Bank stability	Geomorphologist	18	75	107	107	120	50	22	83	37	9
	Instream cover	Fish biologist	12	86	66	78	110	50	96	44	22	96
	Channel bottom stability	Geomorphologist	130	50	80	130	130	130	80	80	80	80
Data Management[c]		Data entry specialist[d]	70	120	120	120	140	100	60	50	40	60
Data Analysis and Report Preparation[e]		Senior botanist and senior fish biologist[f]	190	560	580	560	620	580	400	190	320	390

Table 2-5. Continued

Indicator And Activity		Professional Expertise	Hours By Calendar Year[a]									
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water Temperature[g]												
Data Collection												
	Measured water temperature	Fish biologist	150	150	150	150	150	150	150	150	150	150
	Solar heat transfer		128	32	8	190	14	14	190	14	14	190
	Stream channel geometry		232	94	8		332					332
	Stream flow		27	15	177	174	207					33
Data Management[c]		Data entry specialist[d]	60	40	40	60	90	20	30	20	20	80
Data Analysis and Report Preparation[e]		Senior fish biologist and water quality specialist[f]	530	750	750	750	750	750	750	750	750	750
Anadromous Fish Spawning Habitat												
Data Collection												
	Spawning gravel abundance	Fish biologist	50	64	62	68	76	76	59	37	37	
	Spawning gravel quality		50	64	78	84	92	92	75	53	53	
Data Management[d]		Data entry specialist[d]	20	20	20	20	20	20	20	20	20	
Data Analysis and Report Preparation[e]		Senior fish biologist	40	60	80	90	100	100	90	80	80	
Anadromous Fish Passage and Rearing Habitat												
Data Collection												
	Depth and velocity	Fish biologist	168	168	168	168	168	168	168	168	168	168
	Vertical barrier		168	168	168	168	168	168	168	168	168	168
	Rearing habitat diversity		140	153	162	162	198	160	104	36	36	
Data Management[c]		Data entry specialist[d]	180	170	170	170	190	170	170	170	170	170
Data Analysis and Report Preparation[e]		Senior fish biologist	90	140	160	160	130	140	120	70	70	40

Table 2-5. Continued 3 of 3

Indicator And Activity		Professional Expertise	Hours By Calendar Year[a]									
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Anadromous Fish Occurrence												
Data Collection												
	Adult migration and spawning	Fish biologist	160	160	320	320	320	320	320	320	320	320
	Juvenile rearing		675	675	675	675	675	675	675	675	675	675
Data Management[c]		Data entry specialist[d]	90	90	90	90	90	90	90	90	90	90
Data Analysis and Report Preparation[e]		Senior fish biologist	60	110	110	110	110	110	110	110	110	110
Totals by Professional Expertise												
		Botanist	149	250	394	180	166	167	15	253	61	30
		Senior botanist	245	480	650	590	430	530	200	505	220	275
		Geomorphologist	148	125	187	237	250	180	102	163	117	89
		Fish biologist	1,982	1,855	2,060	2,268	2,512	1,899	2,051	1,664	1,669	2,180
		Senior fish biologist	550	965	1,015	1,015	1,025	1,015	895	730	795	720
		Water quality specialist	265	375	375	375	375	375	375	375	375	375
		Data entry specialist[c]	470	490	500	480	550	410	370	390	350	410

[a] The number of hours in each calendar year reflect the amount of time needed to collect, manage, analyze, and evaluate data if no remedial actions are implemented. The extra time needed to collect, manage, analyze, and evaluate data if remedial actions are implemented is not included in this table. Travel time and the time required to prepare for monitoring each indicator and environmental condition parameter are not included in this table because they may vary, depending on from where the monitoring is conducted, what travel arrangements (if any) must be made, what equipment must be acquired by the monitoring entity, and to what extent the monitors must review or learn the methods.

[b] Basal area hours include basal area reference plot data from WY 2004 on; for the purposes of this estimate, it is assumed that 10 basal area reference plots will be established.

[c] Data management hours include entering data from the data collection forms into GEMS and digitizing and attributing aerial photograph data.

[d] Data entry may also be conducted by the personnel collecting the data.

[e] Data analysis hours are calculated assuming that the queries in GEMS will be used for data analysis calculations. Because the GEMS queries were not available in WY 2001–2003, data analysis hours for those years may be low.

[f] Hours shown are total hours for data analysis and report preparation where 2 professional expertises are noted. Hours are divided equally between the professional expertises.

[g] Simulated water temperature, monthly thermal suitability, and short-term thermal suitability indicators are outputs from the JSATEMP model and do not require specific data collection.

2.2.3 Table 2-2 (Monitoring Year Determination for Monitoring Locations Based on Project Construction or Mitigation Installation Completion Date)

Table 2-2 provides managers of the monitoring program with the information needed to calculate which monitoring year each monitoring location is in any future calendar year. Table 2-2 identifies each monitoring location, the applicable indicators to be monitored at that location, whether the indicator is triggered by Project construction or mitigation installation, and the monitoring year for each monitoring location in WY 2004. Monitoring of many of the vegetation-related indicators is triggered by mitigation installation. Monitoring for many of the water temperature and anadromous fish indicators is triggered by Project construction. Depending on the completion dates of the different Project construction and mitigation installation phases, the monitoring year can be determined.

2.2.4 Table 2-3 (Schedule for Indicator Monitoring by Monitoring Location and Calendar Year)

Table 2-3 provides managers of the monitoring program with an “at-a-glance” schedule for tracking indicator monitoring by monitoring location for calendar years 2001–2010. It builds on the information in tables 2-1 and 2-2 to develop a comprehensive schedule for the first 10 monitoring years, as related to calendar years 2001–2010. This schedule is more complex than the schedule in table 2-1 because it reflects the phasing of the indicator monitoring in response to the phasing of Project construction and mitigation installation, as indicated in table 2-2.

2.2.5 Table 2-4 (Estimated Data Collection Hours by Indicator and Unit Type)

Table 2-4 lists the number of hours necessary to complete data collection activities for each indicator’s base unit (e.g., sampling plot, line transect, or Project segment) in a monitoring year. The hour numbers in table 2-4 were developed based on the amount of time it took to complete monitoring for each indicator in 2001–2003. Managers of the monitoring program can use table 2-4 to calculate the approximate amount of time that will be required to complete data collection activities based on the indicators and monitoring locations being monitored in a monitoring year.

2.2.6 Table 2-5 (Estimate of Annual Hours by Monitoring Indicator and Professional Expertise)

Table 2-5 builds on the information in tables 2-3 and 2-4 to develop an estimate of the number of hours it will take to complete monitoring for each indicator in calendar years 2001–2010. The estimated hours required are also summarized by the professional expertise of those who will conduct the monitoring activities. Managers of the monitoring program can use table 2-5 to determine the personnel and budgetary resources that will be needed for indicator monitoring during each calendar year.

An overview and list of considerations for each table is provided below.

2.3 Rationale Used to Create Tables 2-1–2-5

2.3.1 Introduction

The rationale used to create tables 2-1–2-5 is described below. As mentioned above, many factors complicate the schedule, including phasing of construction and mitigation, monitoring triggers, and unique schedules for indicators.

2.3.2 Table 2-1

Table 2-1 correlates indicator monitoring to the month of data collection for each year of monitoring. The table is adapted from table 4-18 in the MMP and has been revised to incorporate subsequent Adaptive Management Team–related recommendations. Note the following consideration regarding table 2-1.

- A “Year 0” column is included to indicate monitoring activities that are to be conducted immediately after Project construction (within the same season) or in 2001.

2.3.3 Table 2-2

Table 2-2 identifies each monitoring location, the applicable indicators to be monitored at that location, whether the indicator is triggered by Project construction or mitigation installation, and the monitoring year for each monitoring location in 2004. Note the following considerations regarding table 2-2.

- Entries in the “Monitoring Location” column refer to the sampling plots, line transects, cross sections, temperature model segments, and Project segments detailed in the MMP and appendix E.
- Entries in the “Comments” column explain unusual circumstances and exceptions to the monitoring schedule identified in table 2-1.

2.3.4 Table 2-3

Table 2-3 summarizes the data to be collected for each indicator by monitoring location and the first 10 calendar years of the monitoring program. For the purposes of the monitoring program schedule, the IP assumes that the Project will be significantly completed in 2004. Note the following considerations regarding table 2-3.

- Entries in the “Data Location Type” column refer to the sampling plots, line transects, cross sections, temperature model segments, and Project segments detailed in the MMP and appendix E.
- Year 0 monitoring indicates the indicators that are to be monitored immediately following Project construction (within the same season).
- For all plant-related indicators (i.e., all riparian indicators; SRA cover survival, health and vigor, natural recruitment, nonnative vegetative cover, shaded and stream surface indicators; and the riparian and SRA cover qualitative assessments), monitoring year is identical to the number of years that have passed since mitigation was installed. For these indicators, it is assumed that
    - ☐ mitigation installed in fall 1994 will have -fifth-year (MY 5) monitoring conducted in 2001 (because no fifth-year monitoring was conducted in 1999) and tenth-year monitoring (MY 10) conducted in 2004,
    - ☐ mitigation installed between 1998 and 1999 will have third-year (MY 3) monitoring conducted in 2001, and
    - ☐ mitigation installed in 2001 and 2002 will have first-year monitoring conducted in 2002 and 2003, respectively.

  Mitigation installed during or after 2004 will enter the monitoring program the year following installation. See table 2-2 for more information on the monitoring years for all indicators.
- For channel bottom stability monitoring, the monitoring year is identical to the number of years that have passed since Project construction occurred.
- For instream cover monitoring, the monitoring year is identical to the number of years that have passed since Project construction occurred. Project construction did not occur in Reach A, Woz Way to Park Avenue Bypass, and Guadalupe Creek; therefore, for these segments, the monitoring year is identical to the number of years that have passed since monitoring began.
- For bank stability monitoring, monitoring year is identical to the number of years that have passed since Project construction occurred or since the installation of bank stabilization sites was completed.
- For all fish-related indicators, the monitoring year is identical to the number of years that have passed since monitoring began. Monitoring began for all of these indicators in WY 2001 or later, if Project construction was not completed until later. In Segments 1 and 2, the monitoring year is different from the number of years that have passed since Project construction

(constructed in 1994 and 1996). In Segments 3A, 3B, and 3C, the monitoring year is the same as the number of years that have passed since Project construction. Project construction did not occur in Reach A, Woz Way to Park Avenue Bypass, and Guadalupe Creek.

- For the rearing habitat diversity indicator, the first year of monitoring for Reach A (WY 2001) and Guadalupe Creek (WY 2002) set the measurable objective (within 10% of WY 2001 or WY 2002 values), so monitoring will be conducted for 5 years (the number of years required by the MMP) after the first year.
- For water temperature, the raw data to be collected (i.e., measured water temperature, heat transfer, stream channel geometry, and stream flow) are shown rather than the indicators that are outputs of the JSATEMP model (i.e., monthly thermal suitability and short-term thermal suitability).
    - ☐ The solar heat transfer monitoring schedule is driven by changes in vegetation and by the aerial photography acquisition schedule. Monitoring performed immediately after or as soon as possible after Project construction (year 0 monitoring) was done in WY 2001 for all Project segments that were accessible: Reach A; Segments 1, 2, 3A, and 3B; and Woz Way to Park Avenue Bypass (in Segments 3A and 3B, preproject monitoring was conducted). Monitoring performed immediately after Project construction was done for Guadalupe Creek in WY 2002. In WY 2003, new aerial photography was taken for Guadalupe River and Guadalupe Creek. Solar heat transfer field data will be collected in WY 2004 (MY 0 for the entire area together), 2007 (MY 3), 2010 (MY 6), and 2013 (MY 9), when aerial photography will be acquired for both the river and creek.
    - ☐ The stream channel geometry monitoring schedule is driven by completion of Project construction and any additional changes to the low-flow channel. Monitoring performed immediately after or as soon as possible after Project construction (year 0 monitoring)was conducted in WY 2001 for all Project segments that were accessible: Reach A; Segments 1, 2, 3A, 3B, and 3C; and Woz Way to Park Avenue Bypass (in Segments 3A, 3B, and 3C, preproject monitoring was conducted). Monitoring performed immediately after Project construction
        - was conducted in Guadalupe Creek in WY 2002,
        - was conducted in Reach A and Segments 1 and 2 in late 2002 because of bank stabilization work done in those segments in WY 2002 that affected the low-flow channel (monitoring was conducted for only the cross sections affected by the bank stabilization work),
        - was conducted in Segment 3C in WY 2003, and
        - will be conducted in WY 2005 (MY 0) for all Project segments (this is the first year it will be able to be done for Segments 3A and 3B). MY 5 monitoring will take place in all segments in WY 2010, and MY 10 monitoring will take place in 2015.

  - The stream flow monitoring schedule is driven by the stream channel geometry monitoring schedule and by additional measurements in the MMP and requested by the AMT. In WY 2001, stream flow measurements were collected to correspond with the temperature model segments in which stream channel geometry data were collected. In WY 2002, in addition to the measurements associated with stream channel geometry monitoring, the additional 7 monthly measurements requested by the Adaptive Management Team (which are collected to quantify accretions and depletions) were collected in August–October, and the periodic measurements requested by the Adaptive Management Team were collected in August. In WY 2003, the 7 monthly stream flow measurements and the 3 periodic stream flow measurements were collected in addition to the measurement associated with stream channel geometry data collection in Segment 3C. In WY 2004–2005, the 7 monthly stream flow measurements and the 3 periodic stream flow measurements will be collected in addition to any additional measurements associated with stream channel geometry data collection. After WY 2005, the monthly and periodic measurements may be collected at the discretion of the AMT. Stream flow measurements associated with stream channel geometry data collection will be collected in WY 2010 and 2015. Stream flow measurements in addition to those associated with stream channel geometry monitoring and the 7 monthly and 3 periodic measurements in April–October are collected during anadromous fish monitoring in October–April.

- The spawning gravel abundance, spawning gravel quality, depth and velocity, vertical barrier, adult migration and spawning, and juvenile rearing indicators need to be monitored for the entire Project area at once (or as much of the Project area as is available for monitoring).

  - Spawning gravel abundance and spawning gravel quality are monitored for 5 years after Project construction (and, if the AMT determines that it is needed, every fifth year thereafter through MY 40). The monitoring schedule is

    - WY 2002–2006 for Reach A, which has its own measurable objective (WY 2001 is the baseline against which the other years are compared);

    - WY 2003–2007 for Guadalupe Creek, which has its own measurable objective (WY 2002 is the baseline against which the other years are compared); and

    - WY 2005–2009 for the entire Project area (Segments 1–3 and Woz Way to Park Avenue Bypass, which share 1 measurable objective).

    - WY 2001–2004 for the accessible parts of the Project area during, even though the entire Project area cannot be assessed, to monitor gravel levels in the Project area during that time (i.e., before the entire Project is constructed).

  - The depth and velocity and vertical barrier indicators are monitored in all accessible areas for 40 years following Project construction. Monitoring started in WY 2001 and will continue for 40 years after all Project construction is complete (i.e., WY 2044).

- ☐ The adult migration and spawning indicator is monitored in all accessible areas for 10 years following Project construction. Monitoring started in WY 2001 and will continue for 10 years after all Project construction is complete (i.e., WY 2014).
- ☐ The juvenile rearing indicator is monitored in all accessible areas for 10 years following Project construction (i.e., WY 2014) or 10 years after monitoring started, whichever is later.

2.3.5 Table 2-4

Table 2-4 is an estimate of the data collection hours, listed by indicator and by monitoring unit type, required to conduct the monitoring program. The table is based on the amount of time needed to conduct monitoring in 2001–2003. Note the following consideration regarding table 2-4.

- For the riparian vegetation and SRA cover indicators (except the bank stability, instream cover, and channel bottom stability indicators), the data collection hours in MYs 1–5 are the same as in 2001, but data collection hours in MYs 6–40 are 1.5 times greater than 2001 data collection hours because it is expected that, as vegetation becomes denser, riparian vegetation and SRA cover indicators will take longer to monitor.

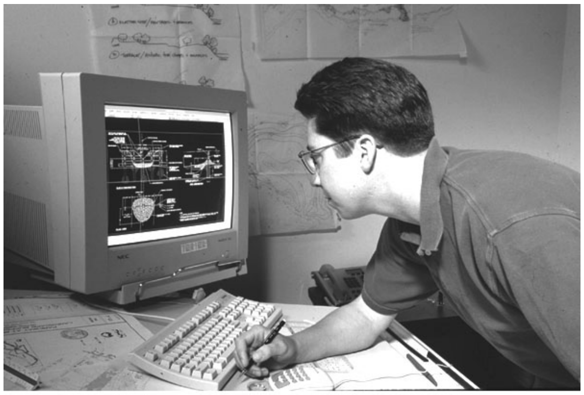
2.3.6 Table 2-5

Table 2-5 is an estimate of the hours, listed by indicator and calendar year, required for each skill set to conduct the monitoring program. The table is based on the monitoring schedule in table 2-1, the monitoring years in table 2-2, the monitoring activities and locations in table 2-3, and the monitoring hours per monitoring unit in table 2-4. Note the following considerations regarding table 2-5.

- Entries in the “Professional Expertise” column are synthesized from the staff skill sets required for each indicator, as described in chapters 4–9. As noted in the table, an independent, dedicated data entry specialist may be substituted for the data collection field staff.
- It is generally assumed that data management includes transferring and synthesizing field-collected data into digital form (database or digital mapping).
- For water temperature, the estimated time for field data collection (i.e., measured water temperature, heat transfer, stream channel geometry, and stream flow) is shown in the data collection field. Times associated with indicators that are outputs of the JSATEMP model (i.e., simulated water temperature, monthly thermal suitability, and short-term thermal suitability) are reflected in the data analysis and report preparation field.

Chapter 3

Data Management



Entering data

3.1 Introduction

Implementation of the MMP will result in the collection of large quantities of monitoring data and information over a time period that could span 40 years or more. The data will be used to perform analyses and generate tables, figures, and maps necessary to create annual mitigation monitoring reports. These reports will be used by the Adaptive Management Team to evaluate the success of the Project's mitigation and to recommend changes to the mitigation and monitoring program, as needed. This chapter describes an environmental monitoring data management system that will support the entry, storage, access, and analysis of the data and related information. The chapter is written for database administration and GIS data management staff (section 3.3.3.3) and assumes an appropriate level of detail based on the experience and background such staff would have with respect to data management.

3.2 System Overview

To meet the long-term data management needs of the MMP, the data will be stored in an integrated environmental information system, the Guadalupe Environmental Monitoring System (GEMS). Monitoring data are primarily collected in the field and are then input into GEMS. The primary components of GEMS are a relational database management system (RDBMS) and a graphical user interface (GUI). The RDBMS has been designed to be eventually linked to the secondary components of GEMS, including a GIS database, the JSATEMP model, a ground-level digital image library (for ground level digital images, scanned photographic prints, and scanned plot stem maps and barrier diagrams) and an aerial digital image library. Figure 3-1 shows an overview of GEMS.

Note: Description of the RDBMS in the IP is based on version 3.0.0 of GEMS.

Using GEMS to manage data has the following benefits.

- Data will be stored in a standardized electronic format.
- Data will be integrated through the use of identification numbers for sampling plots, line transects, and JSATEMP model segments.
- Data will eventually be linked to a GIS database, allowing data to be displayed as maps that show geographic relationships between Project flood protection features, mitigation activities, and monitoring indicators.
- Data from different monitoring indicators will be easy to combine, analyze, and compare in a digital format.
- Data will be maintained without loss or corruption.
- Data access will be improved.

GEMS has been designed to

- have a simple GUI,
- allow multiple user access through multiple "front ends,"
- allow future development of Internet access functionality,
- operate within the existing hardware and network environment,
- require basic technical support to maintain,
- accommodate changes to the monitoring program in response to adaptive management, and
- allow monitoring data to be adapted to changes in information technology.

3.2.1 System Access

GEMS files will be stored on networked desktop personal computers (PCs), with 3 levels of access:

- read-only user,
- read/write user, and
- read/write/administer user.

Read-only users can view, query, and output data. This user group may include the Adaptive Management Team, other responsible agencies, and project managers. This user group could also include the public; however, the policy and management support decisions related to public access are beyond the scope of the IP. GEMS is also designed to allow development of Internet access capability, although Internet access is not specified in the initial system creation.

Read/write users can update and maintain the contents of GEMS, including the RDBMS, GIS database, JSATEMP model, and digital image libraries, as well as generate reports and query GEMS. Read/write users are responsible for data entry, analysis, and quality. The primary read/write user is the project data manager or other such person responsible for ensuring that the contents of GEMS are up-to-date and correct.

The read/write/administer user is the database administrator. In addition to the types of access described above, the database administrator maintains the functionality of GEMS. Maintaining the functionality of GEMS includes providing user support, performing custom report and query programming, performing maintenance, and making regular backup copies of GEMS.

3.3 System Requirements

Information technology will change over the course of the MMP monitoring period. The system requirements described below for computer hardware and software represent appropriate equipment for the immediate term. Although the computer hardware and software will change, GEMS has been designed to allow the data to be converted to new computer systems without loss of data.

The minimum hardware, software, and staff qualifications necessary to support GEMS are described below.

3.3.1 Hardware

Two dedicated PCs will be required for GEMS. One PC will contain the files for the RDBMS, and the second PC will contain GIS data, JSATEMP model data, and digital image libraries. The dedicated PC for the RDBMS requires the following minimum specifications:

- 5 gigabytes (GB) free disk space,
- 128 megabytes (MB) random access memory (RAM),
- 1.0 gigahertz Pentium III processor,
- high-resolution monitor,
- network card, and
- network color printer (capable of printing on 11- by 17-inch paper).

The dedicated PC for GIS data, JSATEMP model data, and digital image libraries requires the following specifications:

- 25 GB free disk space,
- 512 MB RAM,
- 600 megahertz dual Pentium III processor,

- high-resolution monitor,
- 32-bit graphics accelerator card,
- network card,
- color inkjet plotter (Hewlett Packard 755 or equivalent), and
- color printer (capable of printing on 11- by 17-inch paper) (Hewlett Packard 8500 or equivalent).

3.3.2 Software

The following software (with minimum version noted) is required:

- Microsoft Windows NT or 98,
- Microsoft Access 2000,
- ESRI ArcGIS 8.X,
- Global positioning system (GPS)–processing software appropriate for the GPS unit being used (e.g., Trimble Pathfinder Office),
- IBM Lotus 1-2-3 version 5,
- Microsoft Excel 97,
- AutoCAD 2000, and
- a web browser.

3.3.3 Staff Qualifications

3.3.3.1 Data Entry

Data entry can be done by staff with basic computer skills, including data collection staff or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

3.3.3.2 GIS Data Management

GIS data management should be performed by a staff member with a related 4-year college degree (e.g., geography or GIS) and 2 years professional experience using ArcView or ArcInfo software, including digitizing, editing, and plotting. The GIS staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

3.3.3.3 Database Administration

Database administration should be performed by a staff member with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft structured query language (SQL) relational databases.

3.4 System Design

The RDBMS and GUI are designed to work on a Microsoft Windows NT or 98 or higher operating system, with network connectivity to the other GEMS components. Network connectivity allows the RDBMS to be on a separate network drive from the GIS database, JSATEMP model, and digital image libraries.

GEMS has 2 primary aspects: the GUI and the relational database design.

3.4.1 Graphical User Interface

GUIs are used to allow easy interaction with PCs. In GEMS, the GUI incorporates software “windows” with icons (including “buttons”), menus, pull-down lists, and a computer mouse to navigate the RDBMS. The RDBMS includes a main menu and submenus that allow the user to perform various tasks, including data entry and output.

3.4.1.1 Menus

GEMS is designed to provide a simple GUI for 2 primary tasks:

- data entry and
- data analysis.

Pull-down lists and button selections guide the user through the data entry and reporting procedures; minimal computer skills are required. Figure 3-2 shows the main RDBMS menu and figure 3-3 shows an example of a RDBMS data entry menu.

3.4.1.2 Data Entry Graphical User Interface

Field data will be collected using a double entry system. First, monitoring data will be recorded on paper data collection forms. Second, data from the completed data collection forms will be keyed into the RDBMS with data entry screens, called *data entry forms* (figure 3-4). Electronic data entry forms are used to improve efficiency and quality by assisting the user in entering repeated information, using standard codes or values, and checking data format (e.g., numeric or text).

3.4.2 Database Design

3.4.2.1 Relational Database

Most of the monitoring data collected in support of the MMP are stored in a RDBMS developed using Microsoft Access. The RDBMS has the following components:

- primary data tables—tables holding specific information for each monitoring indicator/environmental condition paramater and
- metadata tables—tables with details of common recurring values stored in the primary data tables.

Figures B-1–B-26 in appendix B show the relationships between the primary data tables and the metadata tables for each indicator and environmental condition parameter.

Chapters 4–9 provide a more detailed description of the RDBMS design for each indicator and environmental condition parameter.

3.4.2.1.1 Primary Data Tables

The monitoring data input into the RDBMS are stored in primary data tables (table 3-1). Primary data tables link together different types of data through the use of unique identification numbers that function as database keys. For example, sampling plot identification numbers serve as database keys as they allow different riparian vegetation indicators to be brought together to assist in analysis. Some of the identification numbers used in the RDBMS as database keys are

- individual plant identification number,
- sampling plot identification number,
- line transect identification number,
- temperature model segment identification number (for JSATEMP model segments), and
- cross-section identification number.

Table 3-1. Primary Data Tables in the Relational Database Management System

Monitoring Component	Primary Data Table Name	Data Collection Form (or Data Source)
Riparian vegetation		
	tblRiparianSurvivalHealthVigor	RIP-01
	tblRipQualAssess	RIP-02
	tblRipNatRecruit	RIP-03
	tblRipNativeNonnativeVegCover	RIP-04
	tblRipNonNativeSpecCover	RIP-05
	tblRipTreeHeightBasalArea	RIP-06
SRA cover		
	tblSRASurvivalHealthVigor	SRA-01
	tblSRAQualitativeAssess	SRA-02
	tblSRANaturalRecruitment	SRA-03
	tblSRANonNativeSpecCover	SRA-04
	tblSRAShadedStreamSurface	SRA-05
	tblSRABankStability	SRA-06
	tblSRAInstreamCover	SRA-07
	tblSRAChannelBottomStability	SRA-08
Water temperature		
	tblWaterTemp	WATER-01
	tblHeatTransfer	WATER-02
	tblEmergentVegetation	WATER-03
	tblStreamChannelGeometry	WATER-04
	tblStreamFlowMeasurements	WATER-05
	tblMonthlyThermalSuit	from JSATEMP model
	tblShortTermSuit	from JSATEMP model
Anadromous fish spawning habitat		
	tblSpawnGravAbund	FISH-01
	tblSpawnGravQ	FISH-02
Anadromous fish passage and rearing habitat		
	tblDepthandVelocity	FISH-03
	tblVerticalBarrier	FISH-04
	tblRearHabitatDiv	FISH-05
Anadromous fish occurrence		
	tblAdultMigrationSpawn	FISH-06
	tblJuvinileRearing	FISH-07

3.4.2.1.2 Metadata Tables

Metadata tables are used to store values representing data that are repeated throughout the primary data tables. For example, a unique value is used to represent a plant species. The plant species metadata table includes the 5-letter species code for each plant species and the corresponding full species name (genus and species), common name, and native or nonnative status. When the monitoring data are input into the RDBMS through the GUI, the 5-letter species code can be selected from the metadata table using a pull-down list. This technology is used to enforce data integrity, improve the efficiency of data entry, perform quality assurance checks, and create output reports. Some of the metadata tables in the RDBMS are

- riparian or SRA cover sampling plot,
- riparian line transect,
- riparian vegetation or SRA cover mitigation planting area,
- plant species,
- plant form (tree, shrub, or undetermined),
- health and vigor ratings,
- natural recruitment scores,
- nonnative species cover class scale,
- photo point direction,
- JSATEMP model segment number,
- stream segment,
- spawning gravel size,
- habitat type,
- fish species, and
- fish sex.

3.4.2.1.3 Data Analysis Queries

Data analysis queries are used to summarize and analyze the data in the RDBMS. Chapters 4–9 provide a description of data analysis calculations for each indicator and environmental condition parameter. For most indicators and environmental condition parameters, the RDBMS queries perform all of the calculations listed in the “Calculations” section in chapters 4–9. However, for the stream channel geometry and stream flow environmental condition parameters, some calculations must be conducted in Excel; the RDBMS queries create only a table for exporting the data and then summarize the results of the calculations once they have been entered back into GEMS.

3.4.2.2 JSATEMP Stream Temperature Model

GEMS includes the JSATEMP model. The JSATEMP model is used to run simulations to determine Project effects on water temperatures. Most water temperature monitoring data are put into the JSATEMP model (e.g., stream flow data from SCVWD and U.S. Geological Survey [USGS] stream gages and air temperature data from CIMIS stations). However, only some of the monitoring data are used directly to run the simulations, while other monitoring data, such as solar heat transfer and stream channel geometry, are used to check and calibrate the

JSATEMP model calculations. The JSATEMP model is based in Lotus 1-2-3. A subset of the water temperature monitoring data is stored in the RDBMS data tables.

3.4.2.3 GIS Database

GEMS includes a GIS database. GIS data combines point, line, and area graphics with descriptive attribute data. The GIS data are stored in layers. The GIS database includes layers that geographically describe the location of identification numbers or database keys (section 3.4.2.1.1). Sampling plots and line transects, for example, are graphic layers in the GIS database with the same identification numbers in the RDBMS. GPS identification numbers can be stored in the GIS database as points, along with the identification numbers. These identification numbers allow monitoring data stored in RDBMS tables to be shown on maps accurately and easily. The GIS software specified, ArcView, is Open Database Connectivity (ODBC) compliant. OBDC connectivity enables RDBMS data to be used in ArcView as though it were in ArcView format.

The GIS database will include many layers, not all of which have been identified at this time. The basic layers that support analysis and prepare maps will include base map data, environmental data, boundary data, and monitoring location data.

3.4.2.3.1 Base Map GIS Data

Base map GIS data layers are necessary for general reference and help monitoring team members understand the basic geography of the Project and mitigation areas. The layers are also necessary to produce maps. These base map layers will include

- semirectified natural color aerial digital images of Project and mitigation areas (raster image; see section 3.4.2.5.2);
- parcel and right-of-way (polygon);
- SCVWD topography and contours (line);
- wetted channel (polygon);
- SCVWD Guadalupe River stationing (dynamic segmentation);
- flood zones (polygon; 50-year and 100-year event boundaries);
- utilities and facilities:
  - ☐ potable water (line),
  - ☐ sanitary sewer (line),
  - ☐ storm drain (line),
  - ☐ overhead power (line), and
  - ☐ miscellaneous facilities, as necessary;
- recreational trails (line);

- stream gages (point);
- Project flood protection features (polygon; armored channel, including constructed low-flow channel, and weirs);
- black-and-white digital orthophotograhs (historical orthophotograhs of the Project and mitigation areas);
- USGS 7.5-minute digital raster quadrangle maps (raster image);
- township/range/section/rancho boundaries (polygon); and
- SCVWD orthophotograph survey control points (point).

3.4.2.3.2 Environmental Data

There are several different GIS layers for environmental data, grouped under the following directories: riparian vegetation, SRA cover, water temperature, anadromous fish spawning habitat, anadromous fish passage and rearing habitat, and anadromous fish occurrence layers.

The riparian vegetation layers will include

- qualitative assessment problem areas (polygon),
- nonnative vegetative cover (polygon), and
- riparian vegetation (polygon, after year 5) (both existing and planted).

The SRA cover layers will include

- qualitative assessment problem areas (polygon),
- nonnative vegetative cover (polygon), and
- shaded stream surface area (polygon).

The water temperature layers will include

- water temperature logger locations,
- edges of wetted channel (line), and
- shape of shaded areas (polygon).

The anadromous fish spawning habitat layer will include

- spawning gravel abundance and quality sample locations (point).

The anadromous fish passage and rearing habitat layers will include

- depth and velocity barrier (line),
- vertical barrier (line), and

- habitat type start/end locations (line).

The anadromous fish occurrence layers will include

- live fish/carcass location (point),
- redd location (point), and
- juvenile rearing survey start/end locations (line).

3.4.2.3.3 Boundary Data

Boundary data layers will include

- Project and mitigation area boundaries (polygon),
- segment boundaries (polygon) (Segments 1A, 1B, 2, 3A, 3B, 3C, and Woz Way to Park Avenue; Reach A; and Guadalupe Creek),
- incorporated city/unincorporated county area (polygon),
- SCVWD jurisdictional boundary (polygon), and
- Guadalupe River Park boundaries (polygon).

3.4.2.3.4 Monitoring Locations

Monitoring location layers will include

- sampling plots (polygon) (boundary of the plots, with identification number but no environmental data),
- line transects (line), and
- ground-level digital image locations (point).

3.4.2.3.5 GIS Data Structure and Naming Conventions

The directory structure for GIS data will be based on the SCVWD's existing GIS data structure and file-naming conventions (table 3-2), which includes the following subdirectories:

- shapefile,
- coverage,
- tables,
- images, and
- grid.

Table 3-2. SCVWD GIS Layer-Naming Convention

Layer Name	Description	Subdirectory
Parcels	Land parcels in Santa Clara County	Shapefiles
Aparcel	Air parcels (partial)	Shapefiles
Easement	SCVWD fee and easement	Shapefiles
Creeks	Major streams in Santa Clara County	Shapefiles
Crk	Route for SCVWD jurisdiction streams	Coverages
Flood	Limits of 1% flooding	Shapefiles
Strmdrns	Storm drains (north county only)	Shapefiles
Outfalls	Storm drain outfalls (Guadalupe River only)	Tables
Pipeline	Raw and treated water pipelines	Shapefiles
Rwcs	Raw water turnouts, vaults, etc.	Tables
Trails	Existing and proposed trails (partial)	Shapefiles
Misc_trails	Existing and proposed trails (partial)	Shapefiles
Strm_sta	SCVWD stream flow stations	Shapefiles
Usgs_sta	USGS stream flow stations	Shapefiles
Levees	Levees	Tables
*.TIF, *.JPG	Black and white digital orthophotographs	Images
Usgscont	USGS 1:24,000 contours (approximately 5-foot interval)	Shapefiles
*.TIF, *.JPG	USGS 7.5-minute quadrangles DRG	Images
SC_elev_ft	USGS elevation grid (10-meter resolution)	Grid
Wellgrid	Township/range/section/plot boundaries	Shapefiles

Note: USGS = U.S. Geological Survey.

3.4.2.4 GPS Data

GPS data are used to confirm aerial photography mapping and relocate field data, such as the corners of sampling plots, the end points of line transects, and other monitoring locations. GPS is composed of a hand-held receiver, special software, and satellites. The hand-held receiver and software process signals from satellites to calculate the exact position on earth, in numeric map coordinates. GPS data collected should have a horizontal accuracy of 1 meter.

GPS data are stored in a proprietary format in the memory of the GPS receiver, with a unique identification number. GPS data from the receiver will be downloaded into GEMS using GPS-processing software within 1 week following completion of monitoring activities.

3.4.2.5 Aerial Photographs

Aerial photographs are an important source of information. They provide a record of on-the-ground conditions. Aerial photographs are also a tool that can be used for navigating, mapping locations of field data collection, and assessing some indicators, such as vegetative cover, shaded stream surface, bank stability, and nonnative species cover, in combination with field measurements and verification.

Aerial photographs will be stored as digital images in GEMS in a directory labeled “aerial_digital_image_library” and subdirectory labeled “<flight date>”.

3.4.2.5.1 Aerial Photography Firm Qualifications

A certified commercial aerial photography firm will be used to secure aerial photography of the Project and mitigation areas at the specifications described in the following sections. The firm will have GPS in-flight navigation, metric-quality camera (such as a Zeiss RMK Top 15) with forward motion compensation, and gyro-stabilized camera mount.

3.4.2.5.2 Aerial Photograph Specifications

The following paragraphs describe specifications for aerial photographs.

- **Scale and Percentage of Overlap.** The natural color aerial photograph will be acquired at a nominal photograph scale of 1:3,600 (1 inch = 300 feet) to 1:6,000 (1 inch = 500 feet), suitable for printing at a scale of 1:600 (1 inch = 50 feet). The photographs will be acquired in a single flight line, with normal 60% forward overlap, with the defined Project and mitigation areas falling completely within the one-third of the photograph along the long axis of the flight line. The photographs may be reproduced as 9- by 9-inch contact prints for stereoscope analysis.
- **Acquisition Schedule.** October 2000 aerial photographs taken of Guadalupe River were used for monitoring in WYs 2001–2003. August 2002 aerial photographs taken of Guadalupe Creek were used for monitoring in WYs 2002 and 2003. September 2003 aerial photographs taken of both Guadalupe River and Guadalupe Creek will be used in WYs 2004–2006. For monitoring in subsequent water years, aerial photographs will be acquired during the first 2 weeks of August in 2007, 2010, and every 5 years thereafter (2015, 2020, etc.). Aerial photographs should be taken between 11:00 a.m. and 1:00 p.m.
- **Control Points.** The SCVWD periodically establishes targeted ground control points in Reach A, Segments 1–3, and Guadalupe Creek for survey and other aerial photograph work. These points are usually marked on the ground with white painted crosses. Coordination with the SCVWD land surveying department is necessary to discuss the availability of the most recently established control points. As an alternative, the control points used for the October 2000 and August 2003 aerial photographs may be used (appendix C), as well as USGS orthophotograph quadrangle maps.

- **Scanning.** The color negatives will be scanned at a resolution of 20 microns, resulting in a final pixel ground resolution of 0.25 foot (3 inches). The scanned images will be transformed to natural color and color matched to each other.
- **Rectification.** The scanned aerial photographs will be prepared as a mosaic, registered, and rectified to a best fit to the SCVWD control points with photogrammetric software, such as Orthoview or equivalent, to orient them in the local State Plane Coordinate System by way of independent image rectification.

3.4.2.6 Ground-Level Digital Images

Ground-level digital images included as a part of GEMS are ground-level digital images taken during monitoring of certain indicators, traditional photograph prints, and scanned images of riparian vegetation sampling plot stem plot maps and depth and velocity barrier diagrams. Monitoring of the following indicators and environmental condition parameters includes a ground-level digital image component: riparian vegetation and SRA cover qualitative assessments, tree height, measured water temperature, spawning gravel quality, depth and velocity, vertical barrier, and rearing habitat diversity. The IP specifies that field data collection staff use a high-resolution digital camera to photograph these indicators as digital images. In addition to digital images associated with these indicators, traditional photograph prints also exist that document historical conditions in the Project and mitigation areas. Finally, the IP specifies that stem plot maps for each riparian vegetation sampling plot and basal area reference plot and diagrams of depth and velocity barriers be scanned to create digital images. Contingencies for managing both types of photography as well as scanned images of the stem plot maps and barrier diagrams as part of GEMS are discussed below.

Although digital images, photograph prints, and scanned images are an important type of monitoring data, their value is greatly diminished unless the images/prints and associated metadata (e.g., location, date, subject) are properly stored and maintained. Guidelines for collecting and documenting these metadata are also discussed below.

3.4.2.6.1 Ground-Level Digital Images

Digital images will be stored in GEMS in a directory labeled “ground-level_digital_image_library” and subdirectories labeled “<indicator name>” and “<water year>”.

The digital camera may assign a temporary file name to the image. Once the images are transferred into GEMS, the digital image files will be renamed using the following convention:

<water year><indicator code>_<date><photoID>.jpg (or “.tif”), where

- *water year* is the last two digits of the water year in which the image was taken (e.g., "03" for WY 2003);
- *indicator code* is the alphanumeric naming convention used to identify a particular piece of data (e.g., "BANK001" for the first bank segment monitored in a particular monitoring year; see the data collection section for each indicator in chapters 4–9);
- *date* is the numeric date, in YYMMDD format; and
- *photo ID* is a letter differentiating images taken for the same indicator code on the same date, if applicable (e.g., 03FISH045_030317A and 03FISH045_030317B for two images taken on March 17, 2003, of the 45th fish found during WY 2003 monitoring).

The file extension is generally automatically added by the digital camera after the file format is specified by the user.

Some digital cameras have the option of connecting to a GPS device, so that the exact location of the digital image can be simultaneously recorded, which makes the linking of the images to GEMS much easier. The location of digital images will be recorded as points in a GIS layer. These points can be located by GPS, compass bearing, or distance from known, fixed locations or by marking aerial photographs and subsequently digitized them into the GIS file.

The ground-level digital image library will also include digital images from scanned photograph prints (section 3.4.2.6.2) and scanned plot stem maps and barrier diagrams (section 3.4.2.6.3).

3.4.2.6.2 Photograph Prints

Traditional photograph prints exist that provide documentation of historical conditions in the Project and mitigation areas. These prints will be marked with available appropriate metadata in nonsmear black ink on either the photograph margin or on the edge of the reverse side of the photograph. Care must be taken to ensure that the ink does not bleed through the photograph paper or rub onto another photograph. Photograph prints (and negatives, if available) will be stored in a cool, dark, dry location in clearly marked folders.

Photograph prints can be scanned into digital format for storage in GEMS. Photographs should be scanned at 150 dots per inch and saved in compressed full color format (millions of colors), in JPEG, TIFF, or equivalent file format. Uncompressed bitmap formats, such as Windows BMP or uncompressed TIF formats, are not recommended because of file size considerations. The resulting digital image file should be named using the convention described in section 3.4.2.6.1. The file extension is generally automatically added by the scanning software after the file format is specified by the user.

Digital images of the scanned photograph prints will be stored in GEMS in the directory labeled "ground-level_digital_image_library" and subdirectories labeled “<segment name>” and “<water year>”. The ground-level digital image library will also include ground-level digital images (section 3.4.2.6.1) and scanned plot stem map and barrier diagram digital images (section 3.4.2.6.3).

3.4.2.6.3 Scanned Images

Riparian vegetation sampling plot stem plot maps and depth and velocity barrier diagrams can be scanned into digital format for storage in GEMS. Images should be scanned at 150 dots per inch and saved in compressed full color format (millions of colors), in JPEG, TIFF, or an equivalent file format. Uncompressed bitmap formats, such as Windows BMP or uncompressed TIF formats, are not recommended because of file size considerations. The resulting digital image file should be named using the convention described in section 3.4.2.6.1. The file extension is generally automatically added by the scanning software after the file format is specified by the user.

Digital images of the scanned stem plot maps and barrier diagrams will be stored in GEMS in the directory labeled “ground-level_digital_image_library” and subdirectories labeled “<indicator name>” and “<water year>”. The ground-level digital image library will also include ground-level digital images (section 3.4.2.6.1) and scanned photograph print digital images (section 3.4.2.6.2).

3.4.2.6.4 Image Data Entry

Ground-level digital images, scanned photograph prints, and scanned diagrams will be combined in a ground-level digital image library in GEMS within 1 week of completion of the monitoring activity or scanning of the photograph print, respectively. Corresponding digital image names are input in the RDBMS and stored in the data tables for each applicable indicator.

3.5 Quality Assurance

The field data collection methods and forms in the IP are designed so that complete and correct data are recorded. Some errors may occur during both field data collection and data entry. Data management methods are used to prevent, detect, and correct errors to ensure a high level of data quality.

During data entry, the RDBMS and GUI prevent or detect and notify the user about many types of errors using the methods described below.

3.5.1 Mandatory Fields

Although not all fields in data entry forms must be filled in for every record, there are mandatory fields, such as sampling plot identification number and date. Mandatory data elements can be defined so that the data entry record cannot be saved until a value is entered.

3.5.2 Data Format Checks

The data entry form prevents the incorrect type of data from being entered into a field. For example, text cannot be entered into numeric fields.

3.5.3 Lookup Values

Many data elements have unique values that must be used, such as the 5-letter plant species code, sampling plot identification number, and health and vigor ratings. Rather than enter values for these fields and risk making a typographical error, lookup values are used for the element. The GUI represents the lookup values as data entry pull-down lists, so that a valid value is selected off a list, and no other values are allowed.

3.5.4 Incomplete or Illegible Data

If the field data collection forms have illegible or missing mandatory data, the data entry staff will return the forms, with the errors noted, to the monitoring team member for correction.

3.5.5 Data Entry Report and Field Form Comparison

At the completion of each data entry session, the data entry technician will print out a report of the data entered. This printout is compared to the field data collection forms. The following manual checks are made, and any errors found are corrected.

- Were all field data collection forms entered into GEMS?
- Do the number of lines completed on the forms match the number of database records entered?
- Were the data values on the data collection forms correctly entered into GEMS?

Chapter 4
Riparian Vegetation

Newly planted elderberry seedling

4.1 Introduction

Indicators for success of riparian vegetation mitigation plantings are

- survival,
- health and vigor,
- natural recruitment,
- native vegetative cover,
- nonnative vegetative cover,
- tree height, and
- tree basal area.

Data collection, data management, and data analysis and evaluation are discussed for each indicator and environmental condition parameter (i.e., qualitative assessment of riparian vegetation mitigation plantings) in later sections of this chapter.

4.1.1 Staff Qualifications

To successfully complete data collection, data management, and data analysis and evaluation requirements associated with the riparian vegetation indicators and environmental condition parameter, the following minimum qualifications for staff members conducting the work are recommended.

4.1.1.1 Data Collection

Data collection should be performed by staff members with a related 4-year college degree (e.g., botany, ecology, or biology) and 2 years professional experience in botanical field surveys. Specifically, it is suggested that the staff members have experience with

- visual identification of native and nonnative plants to their scientific names, natural recruitment mechanisms, and plant pathogens;
- interpretation of aerial photographs;
- use of aerial photographs as a field-mapping base; and
- use of a diameter tape, clinometer, and GPS receiver.

The data collection methods for most indicators assume that the work will be conducted by a 2-person monitoring team to facilitate safe and efficient data collection. When 2-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

4.1.1.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional GIS experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft SQL relational databases.

4.1.1.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in the design and analysis of biological field studies, including regression analysis.

4.2 Survival Indicator

The riparian vegetation survival indicator represents the number of live planted trees and shrubs per unit area in the riparian vegetation mitigation planting areas. The purpose of monitoring this indicator is to identify occurrences of plant mortality. Mortality of planted trees and shrubs could decrease the quantity and quality of riparian habitat in the riparian vegetation mitigation area. The measurable objective for the riparian vegetation survival indicator is that a minimum of 100 planted trees and 70 planted shrubs per acre must survive for 3 years after planting (MYs 1–3) (MMP section 4.2.3.2).

4.2.1 Data Collection

4.2.1.1 Permit Requirements

No permits are required for conducting the plant survival monitoring described below.

4.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E),
- plot stem maps showing individual locations of planted trees and shrubs in each sampling plot (appendix F),
- GPS receiver with 1-meter accuracy and/or a metal detector to locate the steel rebar monuments that mark sampling plot corners,
- aluminum plant identification tags (approximately 3 by 1 inches) with attachment wire,
- pencil for marking identification tags, and
- data collection form RIP-01 (1 form per sampling plot; appendix D).

4.2.1.3 Schedule

Survival of each planted tree and shrub will be monitored once a year in August or September for 3 years following planting (MYs 1–3) (chapter 2). If in the third year following planting, a sampling plot contains willows with undetermined growth form, that sampling plot will be monitored in the fourth year following planting. This monitoring will better allow the previously undetermined growth form to be identified as either shrub or tree. This identification is important in determining whether the measurable objective for survival of shrubs and trees has been met in that sampling plot. Survival data will be collected simultaneously with health and vigor data for the first 3 or 4 years following planting and recorded on data collection form RIP-01.

4.2.1.4 Location and Access

The survival indicator will be monitored at the 20 sampling plots located in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2). These sampling plots are labeled RIP-1–20 (appendix E). Access to sampling plots requires coordination with the SCVWD.

4.2.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor plant survival. These steps are described in detail later in this chapter.

To monitor plant survival, the monitoring team will

- locate all planted trees and shrubs in each sampling plot;
- replace identification tags, if missing or damaged;
- determine a health and vigor numeric rating for each planted tree and shrub, based on foliage, wood, and root crown, as described for the health and vigor indicator (section 4.3.1.5.1); and
- record health and vigor data and survival data on data collection form RIP-01.

4.2.1.5.1 Mapping and Documentation

In the Office

1. Using the data collection forms from the previous year, record the plant identification number and species code on the data collection form for the current year.

In the Field

2. Begin monitoring at the downstream end of the riparian vegetation mitigation planting areas in Segments 1A and 1B (figure 1-2).
3. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS database of GEMS) or a metal detector to locate the steel rebar monuments that mark the sampling plot corners.

4. Confirm the sampling plot identification number found on the steel rebar monuments.
5. Locate each planted tree and shrub in the sampling plot, and confirm the number of plants using the plot stem map (appendix F). If a planted tree or shrub cannot be located and evidence of installation is observed (e.g., watering basin or stake), enter "0" under "Plant ID Number." If a planted tree or shrub cannot be located and no evidence of installation is observed, enter "missing" under "Plant ID Number."

   Note: Planted trees and shrubs taller than 4.5 feet should have an identification tag attached at breast height (4.5 feet from the ground surface) on a lateral stem (figure 4-1). Planted trees and shrubs less than 4.5 feet tall should have an identification tag attached to a lateral stem midway along the plant's height.

   a. If the plant is missing its identification tag or the identification tag is damaged, go to step 7.
   b. If the identification tag appears to be damaging the plant, move the identification tag to a smaller stem. The identification tag wire should not girdle the plant and should not be placed on the main stem of the plant. Because the main stem will likely grow faster than lateral stems, avoiding placement of the identification tag here will minimize the chances of girdling the plant.
   c. If a new plant has been planted in the same location as an original plant since the last monitoring effort (this step does not apply to natural recruitment), create an identification tag for the new plant that includes the sampling plot identification number, the plant's 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number followed by "R-yy," where "yy" is the year in which the new plant was planted (e.g., "02" for a plant that was planted in 2002) (figure 4-1). Add "R-yy" to the plant's identification number on the data collection form. Record under "Comments" that the plant has been replaced and the date of replacement.

6. On the data collection form

   - confirm the plant identification number from the identification tag,
   - confirm the 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]) from the identification tag,
   - record the plant form (i.e., tree, shrub, or undetermined), and

     Notes: Vines are included in the shrub category (table F-1 of appendix F).

> *The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.*

- record the plant's health and vigor ratings for foliage, wood, and root crown, following the instructions for the health and vigor indicator (section 4.3.1.5.1).

7. If a plant is missing its identification tag or the identification tag is damaged, do the following.

    a. Locate the plant on the plot stem map (appendix F).
    b. Verify the location and species of the plant in the field.
    c. Relabel the plant with a new identification tag, including the sampling plot identification number, 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number (use the same plant identification number as before).
    d. Attach the identification tag to the base of a lateral stem (not the main stem) at breast height (4.5 feet from the ground surface), making sure to secure the tag without girdling the stem and to give the stem room to grow.
    e. Record on the data collection form the data indicated in step 6 and indicate under "Comments" that the identification tag has been replaced and the date of replacement.

4.2.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the survival indicator.

4.2.2 Data Management

Riparian vegetation survival data will be collected once a year in August or September for 3 years following planting (MYs 1–3). If in the third year following planting, a sampling plot contains willows with undetermined growth form, that sampling plot will be monitored in the fourth year following planting. This monitoring will better allow the previously undetermined growth form to be identified as either shrub or tree. This identification is important in determining whether the measurable objective for survival of shrubs and trees has been met in that sampling plot. Survival data are recorded together with health and vigor data on data collection form RIP-01. These indicators are recorded for each planted tree and shrub in each sampling plot. Riparian vegetation survival data are stored in the RDBMS of GEMS.

4.2.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the survival indicator:

- tblRiparianSurvivalHealthVigor (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblRSHVRatings,
- tblPlantSpecies,
- tblPlantForm,
- tblRipHealthVigorRating,
- tblMembers, and
- tblRSHVTeam.

Figure B-1 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.2.2.2 Data Entry

Data from the RIP-01 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.2.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.2.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- 5-letter species code,

- plant form (i.e., tree, shrub, or undetermined),
- foliage health and vigor numeric rating,
- wood health and vigor numeric rating, and
- root crown health and vigor numeric rating.

4.2.3 Data Analysis and Evaluation

The analysis and evaluation of the survival monitoring data assesses whether the measurable objective of survival of 100 planted trees and 70 planted shrubs per acre over all the riparian vegetation mitigation planting areas will be met for each year for 3 years following planting. In addition, analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met in any of the first 3 years.

Note that vines are included in the shrub category (table F-1 of appendix F) and that the plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub. If in the third year following planting, a sampling plot contains willows with an undetermined growth form, that sampling plot will be monitored in the fourth year following planting to determine whether the measurable objective for survival of shrubs and trees has been met in that sampling plot.

4.2.3.1 Calculations

Calculate the following variables for each sampling plot and for all of the sampling plots for which survival data were collected during the current monitoring year.

- *Percent survival since planting for each planted tree and shrub species and species of undetermined growth form.* For each planted tree and shrub species and each species of undetermined growth form, sum the number of surviving individuals (individuals with a health and vigor rating greater than or equal to 2), divide by the total number of individuals planted for that species, and express as a percentage.
- *Percent survival since planting for all trees.* Sum the number of surviving planted trees (individuals with a health and vigor rating greater than or equal to 2) for all tree species, divide by the total number of trees planted, and express as a percentage.
- *Percent survival since planting for all shrubs.* Sum the number of surviving planted shrubs (individuals with a health and vigor rating greater than or equal to 2) for all shrub species, divide by the total number of shrubs planted, and express as a percentage.

- *Percent survival since planting for all species with undetermined growth form.* Sum the number of surviving planted species with undetermined growth form (individuals with a health and vigor rating greater than or equal to 2) for all species with undetermined growth form, divide by the total number of species with undetermined growth form planted, and express as a percentage.

Calculate the following variables for all of the sampling plots for which survival data were collected during the current monitoring year.

- *Overall tree density (surviving trees per acre).* Sum the number of surviving planted trees and divide by 1.148. This divisor is the area (in acres) of the 20 sampling plots measuring 50 feet by 50 feet per plot. If fewer sampling plots were monitored in the current monitoring year, divide by the total area of the sampling plots that were monitored; each sampling plot is 0.0574 acre.
- *Overall shrub density (surviving shrubs per acre).* Add the total number of surviving planted shrubs and divide by 1.148. This divisor is the area (in acres) of the 20 sampling plots measuring 50 feet by 50 feet per plot. If fewer sampling plots were monitored in the current monitoring year, divide by the total area of the sampling plots that were monitored; each sampling plot is 0.0574 acre.
- *Overall species with undetermined growth form density (surviving species with undetermined growth form per acre*). Add the total number of surviving planted species with undetermined growth form and divide by 1.148. This divisor is the area (in acres) of the 20 sampling plots, each measuring 50 feet by 50 feet per plot. If fewer sampling plots were monitored in the current monitoring year, divide by the total area of the sampling plots that were monitored; each sampling plot is 0.0574 acre.

4.2.3.2 Statistical Analysis Methods

Prepare the following tables:

- *percent survival since planting for each planted tree, shrub, and species with undetermined growth form*;
- *percent survival since planting for all trees, shrubs, and species with undetermined growth form in each sampling plot* (rows) by *year since planting* (columns)*;* and
- *percent survival since planting for all trees, shrubs, and species with undetermined growth form for all sampling plots in each monitoring year combined.*

Prepare the following graphs:

- *overall tree density (surviving trees per acre)* versus *time since planting* (show a horizontal line at 100 trees per acre [the minimum target density]),

- *overall shrub density (surviving shrubs per acre)* versus *time since planting* (show a horizontal line at 70 shrubs per acre [the minimum target density]), and

- *overall species with undetermined growth form density (surviving plants per acre)* versus *time since planting*.

4.2.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **The number of surviving plants for each planted species should not be higher than the number of surviving plants present in the previous year.** Check the data collection forms for errors if more plants were recorded alive than in the previous year. A possible explanation for the higher number of surviving plants is that a particular plant received a health and vigor rating of less than 2 in 1 year but more than 2 in the following year because of improved health or vigor of that plant. Additionally, replacement plantings may increase the number of surviving plants for a species. If the higher number of surviving plants cannot be explained by improved health or vigor or replacement planting and if no errors are found on the RIP-01 data collection forms or in data entry, locate the individual planted tree, shrub, or species with undetermined growth form in the field, confirm the survival status of the individual, and correct GEMS, as appropriate.
- **The species identity of each tree, shrub, and species with undetermined growth form should be identical to that in the previous year.** The assigned species identity for a plant may change, for example because an identification tag was replaced and the wrong species name was put on the tag. Additionally, replacement planting may have occurred and the replaced species was not the same as the species originally planted. If the species identity for an individual changes between monitoring years, verify the species identity of the individual in the field and correct the plant's identification tag, data collection form RIP-01, and/or GEMS, as appropriate.

4.2.3.4 Comparison to Measurable Objective

Compare the total number of surviving trees and shrubs per acre for each year for 3 years following planting to the measurable objective of a minimum of 100 trees per acre and 70 shrubs per acre. For all 20 sampling plots, which have a total area of 1.148 acres, a minimum of 115 planted trees and 81 planted shrubs should survive each year for 3 years following planting. When all sampling plots are not monitored in the same monitoring year, the total number of planted trees and shrubs that should survive in that monitoring year can be calculated by multiplying the number of sampling plots that are monitored (each plot has an area of 0.057 acre) by 5.7 trees and 4.0 shrubs. If some willows are classified as having an undetermined growth form, calculate the densities for both cases (i.e., assume undetermined growth form plants to be shrubs and undetermined growth form plants to be trees). Conduct additional analysis if the measurable objective is not met, and use the results of that analysis to recommend specific remedial actions to the Adaptive Management Team.

Address the following questions in the additional analysis.

- What are the likely causes of mortality for most plants?
- Which species showed the most mortality?
- What area is most suitable for additional planting?
- Will species with currently undetermined growth form likely affect the measurable objective in the future?

Examine the distribution of mortality over the riparian vegetation mitigation planting areas by determining the mortality of each sampling plot and by inspecting the aerial photographs of consecutive monitoring periods. Identify locations within the planting areas with the greatest mortality, and, at these locations, collect data on field indicators for site suitability. Field indicators include soil moisture, soil texture, wildlife browsing, insect damage, and disease prevalence. If these locations are not deemed suitable for riparian tree and shrub species, do not recommend planting additional trees and shrubs in them. Recommend planting in locations that show high survival, good field indicators for survival success, and relatively low density of planted trees and shrubs. If sufficient suitable space for planting is not available, recommend planting in a location outside the riparian vegetation mitigation planting areas.

Investigate the likely causes of mortality by examining health and vigor data of the plants that died. In addition, it may be necessary to do additional field investigations to determine how locations with high mortality differ from locations with low mortality. As a remedial action, the factor that caused mortality may need to be modified. For example, if a location appears too dry for adequate survival, additional irrigation may need to be recommended.

Identify the species that showed the most mortality, using the generated tables and graphs. Do not recommend replanting those species if the location does not appear suitable for them. Alternatively, a different source for these species may be recommended if it appears that there was a problem with the planted material.

Investigate whether species with currently undetermined growth form will likely affect whether the measurable objective is met.

Analyze the trend in survival even if the measurable objective is met for each year for 3 years following planting. If the measurable objective is barely met and the trend indicates that survival levels may decline, it may be appropriate to recommend remedial actions.

4.3 Health and Vigor Indicator

The riparian vegetation health and vigor indicator represents health and vigor of the foliage, wood, and root crown of planted trees and shrubs in the riparian vegetation mitigation planting areas. The purpose of monitoring this indicator is to estimate trends in plant health and to identify sampling plots and locations in the planting areas where the health and vigor of planted trees and shrubs is lacking and where plant mortality may increase. A lack in plants' health and vigor could decrease the quality or quantity of riparian habitat in the riparian vegetation mitigation planting areas. The measurable objective for the riparian vegetation health and vigor indicator is average health and vigor rating must be greater than or equal to 2 ("fair") on a scale of 0–5 for planted trees and shrubs in each riparian vegetation mitigation sampling plot for 5 years after planting (MYs 1–5) (MMP section 4.2.3.3).

4.3.1 Data Collection

4.3.1.1 Permit Requirements

No permits are required for conducting the health and vigor monitoring described below.

4.3.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E),
- plot stem maps showing individual locations of planted trees and shrubs in each sampling plot (appendix F),
- GPS receiver with 1-meter accuracy and/or a metal detector to locate steel rebar monuments that mark sampling plot corners, and
- data collection form RIP-01 (1 form per sampling plot; appendix D).

4.3.1.3 Schedule

Health and vigor of each planted tree and shrub will be monitored once a year in August or September for 5 years following planting (MYs 1–5) (chapter 2). Health and vigor data will be collected simultaneously with survival data for the first 3 years following planting and recorded on data collection form RIP-01.

4.3.1.4 Location and Access

The health and vigor indicator will be monitored at 20 sampling plots located in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2). These sampling plots are labeled RIP-1–20 (appendix E). Access to sampling plots requires coordination with the SCVWD.

4.3.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor health and vigor. These steps are described in detail later in this chapter.

To monitor health and vigor, the monitoring team will

- locate all planted trees and shrubs in each sampling plot;
- determine a health and vigor numeric rating for each planted tree and shrub, based on foliage, wood, and root crown health; and
- record health and vigor data on data collection form RIP-01.

4.3.1.5.1 Mapping and Documentation

Note: Steps 1–6 below are the same methods as shown in the corresponding section under "Survival Indicator" (section 4.2.1.5.1). They have been reproduced here for ease of use.

1. Begin monitoring at the downstream end of the riparian vegetation mitigation planting areas in Segments 1A and 1B (figure 1-2).
2. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS of GEMS) or a metal detector to locate the steel rebar monuments that mark the sampling plot corners.
3. Confirm the sampling plot identification number found on the steel rebar monuments.
4. Locate each planted tree and shrub in the sampling plot, and confirm the number of plants using the plot stem map (appendix F). If a planted tree or shrub cannot be located and evidence of installation is observed (e.g., watering basin or stake), enter "0" under "Plant ID Number." If a planted tree or shrub cannot be located and no evidence of installation is observed, enter "missing" under "Plant ID Number."

Note: Planted trees and shrubs taller than 4.5 feet should have an identification tag attached at breast height (4.5 feet from the ground surface) on a lateral stem (figure 4-1). Planted trees or shrubs less than 4.5 feet tall should have an identification tag attached to a lateral stem midway along the plant's height.

a. If the plant is missing its identification tag or the identification tag is damaged, go to step 6.

b. If the identification tag appears to be damaging the plant, move the identification tag to a smaller stem. The identification tag wire should not girdle the plant and should not be placed on the main stem of the plant. Because the main stem will likely grow faster than lateral stems, avoiding placement of the identification tag here will minimize the chances of girdling the plant.

c. If a new plant has been planted in the same location as an original plant since the last monitoring effort (this step does not apply to natural recruitment), create an identification tag for the new plant that includes the sampling plot identification number, the plant's 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number followed by "R-yy," where "yy" is the year in which the new plant was planted (e.g., "02" for a plant that was planted in 2002) (figure 4-1). Add "R-yy" to the plant's identification number on the data collection form. Record under "Comments" that the plant has been replaced and the date of replacement.

5. On the data collection form

- confirm the plant identification number from the identification tag,
- confirm the 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]) from the identification tag, and
- record the plant form (i.e., tree, shrub, or undetermined).

Notes: Vines are included in the shrub category (table F-1 of appendix F).

The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

6. If a plant is missing its identification tag or the identification tag is damaged, do the following.

   a. Locate the plant on the plot stem map (appendix F).

   b. Verify the location and species of the plant in the field.

   c. Relabel the plant with a new identification tag, including the sampling plot identification number, 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name the first 3 letters of the species name[e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number (use the same plant identification number as before).

   d. Attach the identification tag to the base of a lateral stem (not the main stem) at breast height (4.5 feet from the ground surface), making sure to secure the tag without girdling the stem and to give the stem room to grow.

   e. Record on the data collection form the data indicated in step 5 and indicate under "Comments" that the identification tag has been replaced and the date of replacement.

7. Follow the steps below to assess and record on the data collection form the health and vigor of each planted tree or shrub, based on foliage, wood, and root crown health. It is best to evaluate health and vigor by comparing planted trees and shrubs to normal healthy foliage, wood, and root crowns.

Foliage

a. Look at both the top and underside of individual leaves on all sides of each plant for symptoms of disease. Diseased foliage often contains brown sections, either dieback at the leaf margin or in patches/spots throughout the leaf. Some diseases cause leaves to turn a color that is more red or yellow than normal.

b. Look at leaves on all sides of each plant for signs of browsing by wildlife or damage by insects (e.g., leaves are no longer whole or contain galls).

c. Compare young leaves with mature leaves. Young leaves are usually present near the tips of branches and stems, and mature leaves are usually present near the base of branches and stems. Unhealthy trees and shrubs may produce new leaves that are obviously smaller or more shriveled than mature leaves. Wilted leaves (both young and mature leaves, but often most evident on young leaves) are another indicator of poor foliage health.

d. Using the visual observations described above, give the foliage of each planted tree and shrub a numeric rating from 0 to 5, based on the scale in table 4-1.

e. Record the numeric rating on the data collection form.

Table 4-1. Numeric Rating of Foliage Health and Vigor

Numeric Rating	Narrative Rating	Foliage Condition [a]
5	Excellent	Less than 5% of leaves affected by symptoms of poor health
4	Very good	6–25% of leaves affected by symptoms of poor health
3	Good	26–50% of leaves affected by symptoms of poor health
2	Fair	51–75% of leaves affected by symptoms of poor health
1	Poor	Greater than 75% of leaves affected by symptoms of poor health
0	Dead	Foliage is completely dead

[a] After Daubenmire (modified) (1968).

Wood

a. Look at the wood of the main stems and branches of each plant for signs of disease (e.g., cracked or peeling bark, holes in bark, dieback, or accumulated tree sap on the bark surface). Check whether stems or branches are sunburned, usually indicated by cracked or peeling bark on the south-facing side of the plant.

b. Check stems and branches of each plant for signs of browsing by wildlife (e.g., cut stems and branches) and damage by insects (e.g., galls or holes bored through bark into the stem).

c. Evaluate tree structure. Lack of balance (sections of the tree better developed than others) or weak attachment of dominant branches to the main stem(s) is indicative of poor structure.

d. Using the visual observations described above, give the wood of each planted tree or shrub a numeric rating from 0 to 5, based on the scale in table 4-2.

e. Record the numeric rating on the data collection form.

Table 4-2. Numeric Rating of Wood Health and Vigor

Numeric Rating	Narrative Rating	Wood Condition [a]
5	Excellent	Less than 5% of stems and branches affected by symptoms of poor health
4	Very good	5–25% of stems and branches affected by symptoms of poor health
3	Good	26–50% of stems and branches affected by symptoms of poor health
2	Fair	51–75% of stems and branches affected by symptoms of poor health
1	Poor	Greater than 75% of stems and branches affected by symptoms of poor health
0	Dead	Wood is completely dead

[a] After Daubenmire (modified) (1968).

Root Crown

Note: Root crown, as defined here, is the base of the main stem(s) at the ground surface. This definition may not always represent the root crown as defined anatomically.

a. Check the root crown of each plant for signs of disease (e.g., cracked or peeling bark, holes in the bark, or accumulated tree sap on the bark surface).

b. Check the root crown of each plant for signs of girdling by wildlife and damage by insects.

c. Using the visual observations described above, give the root crown of each planted tree and shrub a numeric rating from 0 to 5, based on the scale in table 4-3.

d. Record the numeric rating on the data collection form.

Table 4-3. Numeric Rating for Root Crown Health and Vigor

Numeric Rating	Narrative Rating	Root Crown Condition [a]
5	Excellent	Less than 5% of stem base(s) affected by symptoms of poor health
4	Very good	6–25% of stem base(s) affected by symptoms of poor health
3	Good	26–50% of stem base(s)affected by symptoms of poor health
2	Fair	51–75% of stem base(s) affected by symptoms of poor health
1	Poor	Greater than 75% of stem base(s) affected by symptoms of poor health
0	Dead	Root crown is completely dead

[a] After Daubenmire (modified) (1968).

4.3.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the health and vigor indicator.

4.3.2 Data Management

Riparian vegetation health and vigor data will be collected once a year in August or September for 5 years following planting (MYs 1–5). Health and vigor data are recorded together with survival data on data collection form RIP-01. These indicators are recorded for each planted tree and shrub in each sampling plot. Riparian vegetation health and vigor data are stored in the RDBMS of GEMS.

4.3.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the health and vigor indicator:

- tblRiparianSurvivalHealthVigor (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblRSHVRatings,
- tblPlantSpecies,
- tblPlantForm,
- tblRipHealthVigorRating,

- tblRSHVTeam, and
- tblMembers.

Figure B-1 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.3.2.2 Data Entry

Data from the RIP-01 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.3.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

4.3.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- 5-letter species code,
- plant form (i.e., tree, shrub, or undetermined),
- foliage health and vigor numeric rating,
- wood health and vigor numeric rating, and
- root crown health and vigor numeric rating.

4.3.3 Data Analysis and Evaluation

The analysis and evaluation of the health and vigor monitoring data assesses whether the measurable objective of an average health and vigor rating exceeding “fair” (numeric rating greater than or equal to 2) for each sampling plot will be met in MYs 1–5. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met in any of the first 5 monitoring years.

4.3.3.1 Calculations

Calculate the following variables:

- *average health and vigor numeric rating for each sampling plot,*
- *average health and vigor numeric rating for all sampling plots combined,* and
- *average health and vigor numeric rating for each species over all sampling plots.*

Note: The average health and vigor numeric rating is calculated over all planted trees and shrubs, including obviously dead plants (numeric rating of 0).

4.3.3.2 Statistical Analysis Methods

Prepare the following tables:

- *average, minimum, and maximum health and vigor numeric ratings* by *sampling plot* (rows) and *monitoring year* (columns) and
- *average, minimum, and maximum health and vigor numeric ratings for all sampling plots* by *species* (rows) and *monitoring year* (columns).

Prepare the following graph:

- *average, minimum, and maximum health and vigor numeric ratings for all the sampling plots* versus *monitoring year*; show a horizontal line at the measurable objective (numeric rating greater than or equal to 2);

Use the graph to assess the trend in health and vigor in MYs 1–5, and determine whether the health and vigor of trees and shrubs are increasing or decreasing over time.

4.3.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Health and vigor numeric ratings are less than or equal to 5.** If health and vigor numeric ratings greater than 5 occur, locate the individual plants in the field and correct data collection form RIP-01 and GEMS, as appropriate.
- **Large changes in health and vigor numeric ratings between monitoring years.** Compare health and vigor numeric ratings between monitoring years for individual plants (e.g., by tabulating the difference between years), and determine whether unexpected changes occurred that cannot be easily explained. Large value changes are likely only under some catastrophe (e.g.,

flood event or insect infestation). If such values are found, examine these plants in the field and determine whether the values are correct. Correct data collection form RIP-01 and GEMS, as appropriate.

4.3.3.4 Comparison to Measurable Objective

Compare the average health and vigor numeric rating for each sampling plot to the measurable objective of greater than or equal to 2. Recommend remedial actions if the average value for any sampling plot is less than 2 in any of the 5 monitoring years.

If the average numeric rating for a sampling plot is less than 2, evaluate the causes of the poor health and vigor. Examine the

- table of *average, minimum, and maximum health and vigor numeric ratings by sampling plot* (rows) *and monitoring year* (columns) to identify sampling plots with low health and vigor numeric ratings and
- table of *average, minimum, and maximum health and vigor numeric ratings for sampling plot by species* (rows) *and monitoring year* (columns) to identify species with low health and vigor numeric ratings.

Conduct a field investigation to find the apparent cause of the low health and vigor numeric rating, which may be indicated by soil moisture, soil texture, shade, wildlife browsing, insect damage, evidence of disease, or other factors.

Recommend remedial actions to the Adaptive Management Team if the measurable objective is not met. The causes of low health and vigor numeric ratings determine what remedial action should be taken. For example, recommend fencing/plant protection cages if the cause is wildlife browsing. The cause of disease may not be immediately apparent, and it may be necessary to recommend involving a professional plant pathologist to identify a disease problem and its treatment.

Health and vigor numeric ratings may be used to help explain poor performance in other vegetation indicators, such as survival or vegetative cover.

4.4 Qualitative Assessment

The riparian vegetation qualitative assessment is an appraisal of the general condition of the riparian vegetation mitigation planting areas. The purpose of the qualitative assessment is to determine whether the riparian vegetation mitigation planting areas are accurately represented by the riparian vegetation mitigation sampling plots and transects and to identify and document problems that may affect the planting areas' ability to provide riparian habitat. This assessment is necessary because for some indicators, only a representative sample of the riparian vegetation mitigation planting areas is monitored. Although the sampling approach is statistically valid, from a site management perspective, it is advantageous to have more extensive data coverage. Problems not identified through monitoring of the riparian vegetation mitigation sampling plots could still decrease the quality or quantity of riparian habitat in the riparian vegetation mitigation planting areas. The riparian vegetation qualitative assessment is an environmental condition parameter.

4.4.1 Data Collection

4.4.1.1 Permit Requirements

No permits are required for conducting the qualitative assessment monitoring described below.

4.4.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E);
- aerial photographs covering the riparian vegetation mitigation planting areas, printed at a scale of 1 inch = 50 feet (the same photographs used for the vegetative cover indicator [section 4.6] can be used here);
- permanent color pens for marking on the aerial photographs;
- a high-resolution digital camera; and
- data collection form RIP-02 (1 form per each segment; appendix D).

4.4.1.3 Schedule

Monitoring for qualitative assessment will be conducted once a year in either August or September for 5 years following planting (MYs 1–5) (chapter 2).

4.4.1.4 Location and Access

The qualitative assessment will be monitored for the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2; appendix E). Each of these segments will be monitored separately. Access to the riparian vegetation mitigation planting areas requires coordination with the SCVWD.

4.4.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to conduct qualitative assessment monitoring. These steps are described in detail later in this chapter.

To conduct qualitative assessment monitoring, the monitoring team will

- assess the riparian vegetation mitigation planting areas,
- take ground-level digital images of problem areas,
- map problem areas on the aerial photographs, and
- record qualitative assessment data on data collection form RIP-02.

4.4.1.5.1 Mapping and Documentation

In the Field

1. Begin monitoring at the downstream end of the riparian vegetation mitigation planting area in Segment 1A (figure 1-2).
2. Systematically walk back and forth through the planting area, visually examining a 10-foot-wide swath at each pass until the entire planting area has been observed.
3. Visually evaluate general survival, health and vigor, tree height, cover, species composition, and plant density of all riparian vegetation mitigation plantings. Identify problems that may affect the planting area's ability to provide riparian vegetation habitat (e.g., browsing from wildlife, damage from insects, plant die-off, vandalism, high nonnative cover, or maintenance issues, such as irrigation problems, weed control, and plant protection). Compare vegetation outside the sampling plots with vegetation in the sampling plots to determine whether the sampling plots are representative of the planting area.
4. Fill out separate data collection forms for the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2.
5. Record the species for which a problem/potential problem is applicable, a description of the problem, and the specific location of the problem. If the problem does not apply to a species or group of species, record "general" under "5-Letter Species Code." If the problem does not have a specific location, record "general" under "Location."
6. Take ground-level digital images of representative problem areas. Record the corresponding digital image number on the data collection form.
7. Map specific problem areas on the aerial photographs with a permanent color pen.

In the Office

8. Download digital images from the digital camera for filing in GEMS.

4.4.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the qualitative assessment. However, depending on the problem/potential problem identified, prompt management actions by the SCVWD may be required. The SCVWD will be immediately alerted to such problems/potential problems (e.g., broken irrigation line). The Adaptive Management Team will be alerted about these problems/potential problems as part of the annual mitigation monitoring report that will be prepared for each monitoring year.

4.4.2 Data Management

Riparian vegetation qualitative assessment data will be collected once a year in August or September for 5 years following planting (MYs 1–5). Qualitative assessment data are recorded on data collection form RIP-02. This assessment is recorded for the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2. Qualitative assessment data and digital images are stored in the RDBMS of GEMS.

4.4.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the qualitative assessment:

- tblRipQualAssess (primary data table),
- tblRipMitPlantArea,
- tblRQAPlants,
- tblPlantSpecies,
- tblRQATeam, and
- tblMembers.

Figure B-2 in appendix B shows the relationships between the primary data table and the metadata tables for the environmental condition parameter.

4.4.2.2 Data Entry

Data from the RIP-02 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.4.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

4.4.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- riparian vegetation mitigation planting area and
- 5-letter species code.

4.4.2.4 Data Structure and Entry for the Aerial Photograph Method

Aerial photographs annotated in the field with qualitative assessment points and polygons will be digitized and converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points and polygons will be attributed with 5-letter species code or other vegetation codes and corresponding problem descriptions. All points and polygons from qualitative assessment monitoring for a given year will be included in 2 shapefiles, named “Qualitative_Assessment_<form>_mmmyy,” where “form” is either point or polygon, “mmm” is month (e.g., “aug”), and “yy” is year (e.g., “01”). These shapefiles will also include qualitative assessment monitoring of SRA cover mitigation (section 5.4).

4.4.3 Data Analysis and Evaluation

The analysis and evaluation of the qualitative assessment monitoring data assists the Corps, SCVWD, and Adaptive Management Team with the management of the riparian vegetation mitigation planting areas. In addition, evaluation of the qualitative assessment data may be needed to determine what remedial actions should be recommended if the measurable objectives for other indicators are not met. If the qualitative assessment data indicate that the condition of the vegetation outside the sampling plots is not similar to the condition of the vegetation inside the sampling plots, determine whether the sampling plots are representative of the riparian vegetation mitigation planting areas by comparing the condition of vegetation inside the sampling plots with the condition of vegetation outside the sampling plots. If the sampling plots are not representative of planting area conditions, a note should be made in the annual mitigation monitoring report, and the sampling plot–derived data should be interpreted accordingly.

4.4.3.1 Calculations

No calculations are necessary.

4.4.3.2 Statistical Analysis Methods

No statistical analysis is necessary.

4.4.3.3 Comparison to Measurable Objective

The riparian vegetation qualitative assessment is an appraisal of the general condition of the riparian vegetation mitigation planting areas. This appraisal has been requested by the SCVWD to facilitate short-term site management; there is no measurable objective for the riparian vegetation qualitative assessment. Digitized qualitative assessment points and polygons and ground-level digital images can be compared from monitoring year to monitoring year to track problem areas that may affect the ability of the riparian vegetation mitigation planting areas to provide riparian vegetation habitat.

4.5 Natural Recruitment Indicator

The riparian vegetation natural recruitment indicator represents the level of establishment by natural reproduction of native trees and shrubs within the riparian vegetation mitigation planting areas. The purpose of monitoring this indicator is to determine whether natural recruitment is occurring within the planting areas. Establishment of native trees and shrubs by natural recruitment indicates sustainability of the mitigation and progress toward a riparian habitat that can perpetuate itself with minimal intervention. The measurable objective for the riparian vegetation natural recruitment indicator is that natural recruitment of native woody species must be apparent in the mitigation area by 5 years following planting (MY 5) (MMP section 4.2.3.4).

4.5.1 Data Collection

4.5.1.1 Permit Requirements

No permits are required for conducting the natural recruitment monitoring described below.

4.5.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E),
- plot stem maps showing individual locations of planted trees and shrubs in each sampling plot (appendix F),
- GPS receiver with 1-meter accuracy and/or a metal detector to locate steel rebar monuments that mark sampling plot corners, and
- data collection form RIP-03 (1 form per sampling plot; appendix D).

4.5.1.3 Schedule

Natural recruitment will be monitored once in August or September for 5 years following planting (MY 5) (chapter 2).

4.5.1.4 Location and Access

The natural recruitment indicator will be monitored at 20 sampling plots located in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2). These sampling plots are labeled RIP-1–20 (appendix E). Access to sampling plots requires coordination with the SCVWD.

4.5.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor natural recruitment. These steps are described in detail later in this chapter.

To monitor natural recruitment, the monitoring team will

- identify native species that have naturally recruited in each sampling plot,
- assess the approximate density of naturally recruited seedlings and vegetative sprouts in each sampling plot,
- determine natural recruitment mechanisms in each sampling plot,
- identify plot-specific characteristics that may influence natural recruitment in each sampling plot, and
- record natural recruitment data on data collection form RIP-03.

4.5.1.5.1 Mapping and Documentation

1. Begin monitoring at the downstream end of the riparian vegetation mitigation planting areas in Segments 1A and 1B (figure 1-2), starting at sampling plot RIP-3.
2. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS of GEMS) or a metal detector to locate the steel rebar monuments that mark the sampling plot corners.
3. Confirm the sampling plot identification number found on the steel rebar monuments.
4. Using the plot stem map (appendix F), make a mental note of the planted trees and shrubs. This step is important because it allows a distinction to be made between planted trees and shrubs and naturally recruited trees and shrubs.
5. Systematically walk back and forth through the sampling plot, visually examining a 10-foot-wide swath at each pass until the entire sampling plot has been observed for native plants that have naturally recruited. Natural recruits may take the form of seedlings or vegetative sprouts. Vegetative sprouts from planted trees and shrubs or other sources should be included as natural recruits only if they are more than 2 feet from the parent plant. Do not include plants that obviously were present prior to the establishment of the sampling plot (e.g., mature trees and shrubs that appear to be much older than the average age of the planted trees and shrubs).
6. Record naturally recruited plant species on the data collection form, using the 5-letter species codes (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]).
7. Systematically walk back and forth through the sampling plot a second time. On this pass, record the natural recruitment and planted tree and shrub observations described below.

    a. Determine an abundance score for each native species showing signs of natural recruitment (table 4-4). Keep a running tally by native species on the data collection form and use this tally to estimate the total number of individual recruited, native plants by species. Use this tally to determine an abundance score from table 4-4.

Table 4-4. Natural Recruitment Abundance Scores

Abundance Score	Narrative Rating	Number of Plants
1	Rare	1–5
2	Common	6–50
3	Abundant	>50

b. Identify possible recruitment mechanism(s) for each native species, such as vegetative recruitment (sprouts from underground roots attached to the parent plant) or recruitment from seed. If the naturally recruited plants are too old to determine their recruitment mechanism, note it under "General Location/Comments."

c. Note any sampling plot–specific characteristics that may have influenced natural recruitment (or lack of natural recruitment) of each native species. Example characteristics are soil moisture, soil texture, sampling plot disturbance, competition with weeds, and access to sunlight.

d. Describe the general location(s) in the sampling plot of natural recruitment by native species.

e. Look for evidence of seed production (i.e., seeds, seed pods, acorns, fruits, seeds, or nuts attached to parent plants or on the ground) on planted trees and shrubs.

4.5.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the natural recruitment indicator.

4.5.2 Data Management

Riparian natural recruitment data will be collected once in August or September for 5 years following planting (MY 5). Natural recruitment data are recorded on the RIP-03 data collection form. This indicator is recorded for each sampling plot. Riparian natural recruitment data are stored in the RDBMS of GEMS.

4.5.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the natural recruitment indicator:

- tblRipNatRecruit (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblRNRPlants,
- tblPlantSpecies,
- tblAbundanceScore,
- tblRecruitMech,
- tblRNRTeam, and
- tblMembers.

Figure B-3 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.5.2.2 Data Entry

Data from the RIP-03 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.5.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.5.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- 5-letter species code,
- abundance score, and
- recruitment mechanism.

4.5.3 Data Analysis and Evaluation

The analysis and evaluation of the natural recruitment monitoring data assesses whether the measurable objective of the occurrence of natural recruitment will be met by MY 5. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

4.5.3.1 Calculations

No calculations are necessary for this indicator.

4.5.3.2 Statistical Analysis Methods

Prepare the following tables.

- *Tree or shrub species that produced or show evidence of producing seedlings or vegetative sprouts* by *sampling plot*. Include species that produced seedlings or vegetative sprouts (rows), the abundance score (1–3) (column), and whether the species produced seedlings (enter an "s") or vegetative sprouts (enter a "v") (column).
- *Characteristics influencing recruitment* by *sampling plot.* Include site-specific factors that appear to affect seedling recruitment or vegetative reproduction. These factors may include dense seedling growth, soil moisture, soil texture, and lack of seed production.
- *Recruitment mechanism* by *sampling plot.* Include all possible recruitment mechanisms, and enter an "x" to indicate which recruitment mechanisms occurred in that sampling plot. Note that there may be more than 1 recruitment mechanism per species in a sampling plot.

4.5.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Abundance scores can only be 1–3.** If abundance scores greater than 3 occur, check the data collection forms. If a data entry error was made, correct GEMS. If no data entry error is found, check the sampling plot during the next field visit, determine what the observation should have been, and correct the data collection form and GEMS, as appropriate.

4.5.3.4 Comparison to Measurable Objective

Determine whether natural recruitment occurs for native riparian tree and shrub species. If recruitment does not occur, determine whether any of the recorded characteristics influencing recruitment can explain the lack of reproduction, and recommend remedial actions to the Adaptive Management Team that would facilitate natural recruitment. In addition, recommend continued monitoring of this indicator if natural recruitment is not observed by MY 5.

4.6 Native Vegetative Cover and Nonnative Vegetative Cover Indicators

Note: *Riparian vegetation native vegetative cover and riparian vegetation nonnative vegetative cover are separate indicators with different measurable objectives, but, because the data collection, data management, and data analysis and evaluation methods are similar for both indicators, the indicators have been combined into 1 section.*

The riparian vegetation native vegetative cover and nonnative vegetative cover indicators represent the percentage of ground surface covered by a vertical projection of *native* vegetative canopy (absolute cover) and the percentage of the total vertical projection of native and nonnative vegetative canopy that consists of *nonnative* vegetative cover (relative cover). The purpose of monitoring these indicators is to determine whether the riparian vegetation mitigation planting areas provide sufficient native vegetative cover and to assess whether relative cover by nonnative vegetation remains sufficiently small. The quantity of cover provided by native trees and shrubs is a measure of plant health. In addition, native vegetative cover provides cover for wildlife. Monitoring of the nonnative vegetative cover will enable early intervention to reduce the competition by nonnative plants. This intervention is important because competition by nonnative plants can reduce the performance of planted native trees and shrubs, as well as the performance of naturally recruiting native species.

The measurable objective for *native vegetative cover* is that, by 40 years following planting, either native trees and shrubs must provide absolute cover of 75% and 45%, respectively, or, if native shrub cover is at least 30%, native tree cover in excess of 75% can be substituted for shrub cover. A total combined cover for native trees and shrubs of at least 85% must be attained by MY 40 (MMP section 4.2.3.5).

The measurable objective for *nonnative vegetative cover* is a relative cover of less than 15% for combined nonnative tree and shrub species and less than 5% for giant reed (*Arundo donax*) (MMP section 4.2.3.6).

In combination or singly, 3 methods will be used to collect vegetative cover data: the visual estimation method, the line intercept method, or the aerial photograph interpretation method. Use the visual estimation method to collect nonnative vegetative cover data in MYs 1–5. Use the line intercept method to collect data for native vegetative cover and nonnative vegetative cover in MYs 4, 5, and 10. Use the aerial photograph interpretation method to collect data for native vegetative cover and nonnative vegetative cover in MYs 10, 16, 22, 28, 34, and 40.

4.6.1 Data Collection

4.6.1.1 Permit Requirements

No permits are required for conducting the native and nonnative vegetative cover monitoring described below.

4.6.1.2 List of Equipment

4.6.1.2.1 Visual Estimation Method

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (preferably laminated) covering the riparian vegetation mitigation planting areas (i.e., Segments 1A, 1B, and 2), printed at a scale of 1 inch = 50 feet;
- permanent color pens (at least 4 colors) for marking on the aerial photographs; and
- data collection form RIP-05 (1 form per planting area; appendix D).

4.6.1.2.2 Line Intercept Method

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 50 line transects (appendix E),
- 300-foot measuring tape,
- chaining pins to secure the measuring tape,
- long pole or telescoping stadia rod,
- GPS receiver with 1-meter accuracy and/or a metal detector to locate the steel rebar monuments that mark line transect start and end points, and
- data collection form RIP-04 (1 form per sampling plot; appendix D).

4.6.1.2.3 Aerial Photograph Interpretation Method

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (preferably laminated) covering the riparian vegetation mitigation planting areas, printed at a scale of 1 inch = 50 feet, and
- permanent color pens for marking aerial photographs (at least 5 colors).

4.6.1.3 Schedule

Native vegetative cover will be evaluated once a year in August or September for MYs 4, 5, and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2).

Nonnative vegetative cover will be monitored once a year in August or September for MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2).

The monitoring method to be used depends on the monitoring year. In MYs 1–5, the visual estimation method will be used to measure nonnative vegetative cover. In MYs 4 and 5, the line intercept method will be used to measure native vegetative cover and nonnative vegetative cover. In MY 10, both the line intercept method and the aerial photograph interpretation method will be used to measure native vegetative cover and nonnative vegetative cover. By using both methods in MY 10, the Adaptive Management Team will be able to determine whether aerial photographs provide a reliable estimate of tree and shrub cover. After MY 10, if the aerial photograph interpretation method provides a reliable estimate of native tree and shrub cover, the line intercept method will no longer be used. If the Adaptive Management Team determines that the aerial photograph method does not provide a reliable estimate of native vegetative cover and nonnative vegetative cover, the line intercept method will continue to be used on the same schedule proposed for aerial photograph interpretation.

Where the data are recorded depends on the monitoring method being used. Nonnative vegetative cover will be recorded on data collection form RIP-05 when the visual estimation method is used (MYs years 1–5). Native vegetative cover and nonnative vegetative cover will be recorded on data collection form RIP-04 when the line intercept method is used (MYs 4, 5, and 10). Native vegetative cover and nonnative vegetative cover will be recorded on aerial photographs when the aerial photograph interpretation method is used (MYs 10, 16, 22, 28, 34, and 40).

4.6.1.4 Location and Access

For the visual estimation method, the nonnative vegetative cover indicator will be monitored at Segments 1A, 1B, and 2, along the west side of the Guadalupe River (appendix E).

For the line intercept method, the native vegetative cover and nonnative vegetative cover indicators will be monitored at 50 line transects located in the riparian vegetation mitigation planting areas (line intercept method) in Segments 1A, 1B, and 2, along the west side of the Guadalupe River. The line transects are numbered RIP-T1–T50, starting at the downstream end of Segments 1A and 1B (appendix E).

For the aerial photograph interpretation method, the native vegetative cover and nonnative vegetative cover indicators will be monitored in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2 (appendix E).

Access to these areas requires coordination with the SCVWD.

4.6.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor vegetative cover. These steps are described in detail later in this chapter.

To monitor native vegetative cover and nonnative vegetative cover, the monitoring team will

- visually estimate cover of nonnative trees, nonnative shrubs, and giant reed in the riparian vegetation mitigation planting areas (MYs 1–5);
- evaluate cover of trees and shrubs using the line intercept method (MYs 4, 5, and 10) and/or the aerial photograph interpretation method (MYs 10, 16, 22, 28, 34, and 40); and
- record vegetative cover data on data collection form RIP-04 (if using the line intercept method) or on data collection form RIP-05 (if using the visual estimation method).

4.6.1.5.1 Mapping and Documentation

4.6.1.5.1.1 Visual Estimation Method (monitoring years 1–5; nonnative vegetative cover only)

1. Begin monitoring at the downstream end of the riparian vegetation mitigation planting area in Segment 1A (figure 1-2). The nonnative vegetative cover indicator will be monitored at each of the 3 large sections of the riparian vegetation mitigation planting area shown on the aerial photographs (i.e., Segments 1A, 1B, and 2) (appendix E).
2. Systematically walk back and forth through the planting area, visually examining a 10-foot-wide swath at each pass until the entire planting area has been observed for nonnative vegetative cover. Note areas with concentrations of nonnative trees, nonnative shrubs, or giant reed.
3. Map the vegetative cover of nonnative trees, nonnative shrubs, and giant reed in the riparian vegetation mitigation planting areas on the aerial photographs.
    a. Trace the edge of the canopy of all *nonnative* trees with a permanent color pen (use 1 color for all nonnative trees).
    b. Trace the edge of the canopy of all *nonnative* shrubs with a permanent color pen (use 1 color for all nonnative shrubs). Some shrubs may not be visible on the aerial photograph because of dense tree canopy cover; map these shrubs using tree canopies and other recognizable landmarks as references.
    c. Trace the edge of the canopy of all giant reed with a permanent color pen (use 1 color for giant reed).

    Note: It is recommended that nonnative vegetative cover be mapped on laminated digital printouts of the aerial photographs or an acetate overlay on the aerial photographs, rather than on the aerial photographs themselves, because there may be limited sets of prints available for all indicators for the entire monitoring year.
4. Visually estimate the percent relative cover contributed by each species of nonnative tree and nonnative shrub and by giant reed, and determine a cover class using the ranges given in table 4-5. Relative cover is the percentage of

the total vegetative cover that consists of a particular plant species or vegetation category. Relative cover does NOT include bare ground.

Table 4-5. Cover Class by Visually Estimated Percent Relative Cover

Cover Class	Visually Estimated Relative Cover (%)
1	<5
2	6–15
3	16–50
4	51–75
5	>75

5. Visually estimate the combined percent cover contributed by nonnative trees, nonnative shrubs, and giant reed and determine both the percentage (or as narrow a percentage range as possible) of nonnative cover and the corresponding cover class (table 4-5).

   Note: Determining a percentage (or narrow percentage range) for the combined cover is important because the percentage ranges used for the cover classes are broad.

6. Record the following data on data collection form RIP-05 (1 form for each planting area):

   a. 5-letter species code for all nonnative trees, nonnative shrubs, and giant reed observed (the 5-letter species code consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Arundo donax* is ARDON]);

   b. specific location of each concentration of nonnative vegetation;

   c. cover class of each species of nonnative trees and nonnative shrubs and of giant reed; and

   d. percentage and cover class of combined nonnative trees, nonnative shrubs, and giant reed.

4.6.1.5.1.2 Line Intercept Method (monitoring years 4, 5, and 10)

1. Begin monitoring at the downstream end of the riparian vegetation mitigation planting area in Segment 1A, starting at line transect RIP-T1.
2. Locate a line transect using the aerial photograph. If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS of GEMS) or a metal detector to locate the steel rebar monuments that mark the line transect start and end points.
3. Confirm the line transect number found on the steel rebar monument.

4. With the 0-foot mark at the line transect start point, or west end, of the line transect, stretch the measuring tape taut along the ground between the line transect start and end points and secure ends with chaining pins. The measuring tape now serves as the line transect.
5. Starting at the 0-foot mark, record on data collection form RIP-04 the native or nonnative tree or shrub cover that intersects the line transect (figure 4-2).
    a. Record the 5-letter species code for each plant species (record tree species under "Tree" and shrub species under "Shrub"). If multiple species overlap, record all species on the same line in the appropriate column. If no cover intersects the line transect, record "none" under "Tree."
    b. Record the first point (start point) at which the plant species (or group of species, in the case of overlapping cover) intersects the line transect (to the nearest 0.5 foot).
    c. Record the last point (end point) at which that same plant species (or group of species) intersects the measuring tape/line transect (to the nearest 0.5 foot).

    Notes: It may help to carry a long pole or telescoping stadia rod, which can be extended up into the vegetation, to act as a straight line between the vegetation being measured and the line transect.

    If a tree or shrub's canopy extends beyond the beginning or end of the line transect, record the beginning or end point of the patch of vegetative cover as 0.0 or the end point of the line transect, respectively.

    Vines and species with undetermined growth form are included in the shrub category (table F-1 of appendix F). The only plants with an undetermined growth form are red willow, arroyo willow, and shining willow for the first 3 years after planting.

    The 5-letter species code consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for Salix exigua *is SAEXI).*
6. Continue to walk along the line transect, and each time a change in cover occurs, begin a new line on the data collection form. A change in cover is the start and stop of each plant species. For example, in figure 4-2, no cover exists from 0 to 2 feet (record "none" under "Tree"). The cover changes at 2 feet when *Platanus racemosa* starts (on the next line, record PLRAC under "Tree"). The cover changes at 5 feet when *Sambucus mexicana* starts (on the next line, record PLRAC under "Tree" and SAMEX under "Shrub"). The cover changes again at 6.5 feet when *Platanus racemosa* stops (on the next line, record SAMEX under "Shrub," and don't record anything under "Tree").
7. Continue along the line transect, recording the data listed in steps 5 and 6, until the cover for the entire line transect has been measured.

Note: Line transects 3–12 intersect vegetation planted at different times (1994 and 1998 and 1999). Cover data for vegetation planted in 1994 will be collected along the line transects on a different schedule than for vegetation planted in 1998 and 1999. The dividing line between vegetation planted in 1994 and vegetation planted in 1998 and 1999 is the secondary channel (figure A-1, pages 6–10 in appendix E). The vegetation planted in 1994 is located on the west side of the secondary channel, and the vegetation planted in 1998 and 1999 is located on the east side of the secondary channel.

4.6.1.5.1.3 Aerial Photograph Interpretation Method (monitoring years 10, 16, 22, 28, 34, and 40)

1. In the field, map the vegetative cover of trees and shrubs at the riparian vegetation mitigation planting areas (i.e., Segments 1A, 1B, and 2) (appendix E).
    a. Trace the edge of the canopy of all planted and recruited *native* trees with a permanent color pen (use 1 color for all native trees).
    b. Trace the edge of the canopy of all *nonnative* trees with a permanent color pen (use 1 color for all nonnative trees).
    c. Trace the edge of the canopy of all planted and recruited *native* shrubs with a permanent color pen (use 1 color for all native shrubs). Some shrubs may not be visible on the aerial photograph because of dense tree canopy cover; map these shrubs using tree canopies and other recognizable landmarks as references.
    d. Trace the edge of the canopy of all *nonnative* shrubs with a permanent color pen (use 1 color for all nonnative shrubs). Some shrubs may not be visible on the aerial photograph because of dense tree canopy cover; map these shrubs using tree canopies and other recognizable landmarks as references.
    e. Trace the edge of the canopy of all giant reed with a permanent color pen (use 1 color for giant reed).

    Note: It is recommended that vegetative and nonnative vegetative cover be mapped on laminated digital printouts of the aerial photographs or an acetate overlay on the aerial photographs, rather than on the aerial photographs themselves, because there may be limited sets of prints available for all indicators for the entire monitoring year.

4.6.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the vegetative cover indicator.

4.6.2 Data Management

Native vegetative cover will be monitored once a year in August or September for MYs 4, 5, and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2). Nonnative vegetative cover will be monitored once a year in August or September for MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2). In MYs 1–5, the visual estimation method will be used to monitor nonnative vegetative cover in the riparian vegetation mitigation planting areas. In MYs 4 and 5, the line intercept method will be used to measure native vegetative cover and nonnative vegetative cover. In MY 10, both the line intercept method and the aerial photograph interpretation method will be used. After MY 10, the aerial photograph interpretation method will be used instead of the line intercept method, if the aerial photograph interpretation method has been deemed to provide a reliable estimate of native vegetative cover and nonnative vegetative cover.

All native vegetative cover and nonnative vegetative cover data will be stored in GEMS: data collected using the line intercept method (based on line transects) and visual estimation method (based on the riparian mitigation vegetation planting areas) will be entered in the RDBMS and data collected using the visual estimation method and aerial photograph interpretation method (based on the riparian vegetation mitigation planting areas) will be entered in the GIS database.

4.6.2.1 Visual Estimation Method

4.6.2.1.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the nonnative vegetative cover indicator using the visual estimation method:

- tblRipNonNativeSpecCover (primary data table),
- tblRipMitPlantArea,
- tblCoverClass,
- tblRNSCPlants,
- tblPlantSpecies,
- tblRNSCTeam, and
- tblMembers.

Figure B-4a in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.6.2.1.2 Data Entry

Data from the RIP-05 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.6.2.1.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.6.2.1.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- riparian vegetation mitigation planting area,
- 5-letter species code,
- cover class, and
- total cover class.

4.6.2.1.4 Data Structure and Entry for Aerial Photographs

In MYs 1–5, vegetative cover will be evaluated using aerial photographs and GIS. Aerial photographs annotated in the field with nonnative vegetative cover points and polygons will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points and polygons will be attributed with 5-letter species codes. All points and polygons from nonnative vegetative cover monitoring for a given year will be included in 2 shapefiles, named "Nonnative_Tree_and_Nonnative_Shrub_<form>_mmmyy," where "form" is either point or polygon, "mmm" is month (e.g., "aug"), and "yy" is year (e.g., "01"). These shapefiles will also include nonnative vegetative cover monitoring of SRA cover mitigation (section 5.6).

4.6.2.2 Line Intercept Method

4.6.2.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the native vegetative cover indicator using the line intercept method:

- tblRipNativeNonnativeVegCover (primary data table),
- tblRiparianTransect,
- tblRVCCover,
- tblRVCPlants,
- tblPlantSpecies,
- tblPlantForm,
- tblRVCTeam, and
- tblMembers.

Figure B-4b in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.6.2.2.2 Data Entry

Data from the RIP-04 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.6.2.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.6.2.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- line transect number,
- 5-letter species code, and
- plant form.

4.6.2.3 Aerial Photograph Interpretation Method

4.6.2.3.1 Data Structure and Entry

In MY 10 and continuing every sixth year thereafter (MYs 10, 16, 22, 28, 34, and 40), vegetative cover will be evaluated using aerial photographs and GIS. Aerial photographs annotated in the field with vegetative cover points and polygons will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points and polygons will be attributed vegetation categories (i.e., native tree, native shrub, nonnative tree, nonnative shrub, or giant reed). All points and polygons from vegetative cover monitoring for a given monitoring year will be included in 2 shapefiles, named "Riparian_Cover_<form>_mmmyy," where "form" is point or polygon, "mmm" is month (e.g., "aug"), and "yy" is year (e.g., "01").

Using GIS query capabilities, the GIS specialist will calculate riparian cover values (square feet, percentage of area for native vegetative cover, and percentage of total cover for nonnative vegetative cover) for the riparian vegetation mitigation planting areas.

4.6.3 Data Analysis and Evaluation

The analysis and evaluation of the native vegetative cover monitoring data assesses whether the measurable objective of 75% native tree cover and 45% native shrub cover will be met by year 40. (If native shrub cover is at least 30%, native tree cover in excess of 75% can be substituted for native shrub cover). In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

The analysis and evaluation of the nonnative vegetative cover monitoring data assesses whether the measurable objective of less than 5% giant reed relative cover and less than 15% combined nonnative trees and shrubs will be met in MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40). In addition, areas where removal of nonnative species needs to occur, if any, should be identified.

4.6.3.1 Calculations

4.6.3.1.1 Visual Estimation Method

No calculations are necessary.

4.6.3.1.2 Line Intercept Method

4.6.3.1.2.1 Native Vegetative Cover

The calculations described below should be made for these native vegetation categories:

- native trees,
- native shrubs (including vines), and
- combined native tree and shrub cover.

Calculate the following variables.

- *Percent absolute cover for each vegetation category* by *line transect*. Sum the lengths for each vegetation category and divide by the total length of the transect. Because of native vegetation cover overlap, total absolute cover for all vegetation categories may exceed 100%.

- *Average absolute cover for the riparian vegetation mitigation planting areas for each vegetation category* (as a weighted average of the vegetation category values for the line transects, which is necessary because the line transects are different lengths). Use the following formula:

  $C = S(C_i L_i / L_s)$,

  where C is the average absolute cover for the riparian vegetation mitigation planting areas for each vegetation category, C_i is the absolute cover value for the vegetation category for the i^{th} line transect, L_i is the length of the i^{th} line transect, L_s is the sum of the lengths of all line transects, and S denotes summation over all 50 line transects ($i = 1 \ldots 50$). If not all 50 line transects are monitored in the current monitoring year, the summation will be over the total number of line transects that are monitored in the current monitoring year.

- *Relative cover of native tree and shrub species for the riparian vegetation mitigation planting areas*. Use the following formula:

  $R_{nn} = C_{nn}/C_c$,

  where R_{nn} is the relative cover of each native tree and shrub species, C_{nn} is the cover (in feet) of that native tree and shrub species over all transects, and C_c is the cover of all native and nonnative trees and shrubs combined over all transects (the total length of all transects that is covered by vegetation).

4.6.3.1.2.2 Nonnative Vegetative Cover

The calculations described below should be made for these nonnative vegetation categories: nonnative trees, nonnative shrubs, and giant reed.

Calculate the following variables.

- *Relative cover of each nonnative tree and shrub species for the riparian vegetation mitigation planting areas*. Use the following formula:

  $R_{nn} = C_{nn}/C_c$,

  where R_{nn} is the relative cover of each nonnative tree and shrub species, C_{nn} is the cover (in feet) of that nonnative tree and shrub species over all transects in the planting areas, and C_c is the cover of all native and nonnative trees and shrubs combined over all transects in the planting areas (the total length of all transects in the planting areas that is covered by vegetation).

- *Relative cover of nonnative tree and shrub species and giant reed for the riparian vegetation mitigation planting areas.* Use the following formula:

  $R_{nn} = C_{nn}/C_c$,

  where R_{nn} is the relative cover of all nonnative tree and shrub species and giant reed in the planting areas, C_{nn} is the cover (in feet) of the nonnative tree and shrub species or giant reed over all transects in the planting areas, and C_c is the cover of all native and nonnative trees and shrubs combined over all transects in the planting areas (the total length of all transects in the planting areas that is covered by vegetation).

4.6.3.1.3 Aerial Photograph Interpretation Method

4.6.3.1.3.1 Native Vegetative Cover

Calculate the *percent absolute cover for each native vegetation category* (native trees, native shrubs, and combined native trees and shrubs) by adding the areas of all polygons of that category and dividing them by the total area of the riparian vegetation mitigation planting areas monitored in the current monitoring year.

Note: Do not count twice the overlapping native tree or shrub cover when summing the total area of all native tree or shrub vegetation polygons in the riparian vegetation mitigation planting areas.

The MMP requires that a regression analysis (Draper and Smith, 1966) also be performed in MY 10 and all later monitoring years to confirm that the riparian vegetation mitigation planting areas are progressing toward the 40-year measurable objective. For the regression analysis, also consider the spatial variation in cover at a particular year. Identify all 50 line transects on the aerial photograph, and measure the cover of native trees and shrubs on the photograph for each transect. The overall estimate for native cover based on the polygon measurements will be more accurate than the line transect measurements made on the aerial photographs; however, line transect measurements capture spatial variation in cover.

4.6.3.1.3.2 Nonnative Vegetative Cover

Calculate the *relative percent cover for nonnative trees and shrubs* and *relative percent cover for giant reed* in the riparian vegetation mitigation planting area by summing the areas of all polygons of each nonnative vegetation category in the riparian vegetation mitigation planting areas and dividing the sum by the total area of all vegetation category polygons (both native and nonnative vegetation category polygons) in the riparian vegetation mitigation areas.

Note: Do not count twice the overlapping nonnative tree and shrub cover or overlapping giant reed cover when summing the total area of all nonnative trees and shrubs or giant reed. In addition, do not count twice *the overlapping native and nonnative cover when summing the total area of all vegetation polygons in the riparian vegetation mitigation planting areas.*

4.6.3.2 Statistical Analysis Methods

4.6.3.2.1 Native Vegetative Cover

Annually, create cumulative tables and graphs; each year, data will be added to the data collected in previous years (line intercept and aerial photograph interpretation methods only). These cumulative tables and graphs are described below.

Prepare the following table:

- *absolute native tree, native shrub, and combined native tree and shrub cover* by *line transect* and *monitoring year* (line intercept method, MYs 4, 5, and 10 only).

Prepare the following graph:

- *average absolute native tree cover, average absolute native shrub cover, and average combined absolute native tree and shrub cover for the riparian vegetation mitigation planting areas* by *year* (line intercept method and aerial photograph interpretation method, MYs 4, 5, 10, 16, 22, 28, 34, and 40).

At MY 10, determine whether the values for absolute native tree cover and absolute native shrub cover obtained using the aerial photograph interpretation method are sufficiently close to values obtained using the line intercept method. Use a t-test to compare the mean absolute native tree cover and mean absolute native shrub cover values for all the transects in each riparian vegetation mitigation planting area (obtained using the line intercept method) to the absolute native tree cover and absolute native shrub cover values for that riparian vegetation mitigation planting area (obtained using the aerial photograph interpretation method).

At 10 years after planting and every monitoring year thereafter, use regression analysis (Draper and Smith, 1966) to calculate the predicted value for native tree cover and shrub cover at MY 40. Nonlinear regression is probably the most appropriate model for the relationship because the relationship is probably not linear but instead follows a saturation or sigmoidal relationship.

Evaluate the relationship between native cover and monitoring years, and chose a statistical model according to that relationship (Draper and Smith, 1966). A statistical test for determining whether the native vegetative cover will be at or above the measurable objective by MY 40 could have very low statistical power for any year until MY 30 because MY 40 will be far beyond the range of measured values. Assess qualitatively the likelihood that the required native cover value will be attained.

4.6.3.2.2 Nonnative Vegetative Cover

Prepare the following tables (line intercept and aerial photograph interpretation methods only):

- *average relative nonnative tree and shrub cover value* (row) by *monitoring year* (column) and
- *average relative giant reed cover value* (row) by *monitoring year* (column).

4.6.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **All native cover values are between 0 and 100%.** Examine the range of native and nonnative cover values, and verify that native and nonnative cover values for each vegetation category do not exceed 100%. The total area occupied by native and nonnative trees and shrubs and giant reed cannot exceed 100%.

- **Species composition of line transects does not change significantly between years.** The cover of native and nonnative species for a transect may vary slightly between years because of measurement error; however, barring removal of nonnative species or other sources of mortality, absolute cover of native species and relative cover of nonnative species is not expected to change significantly between years. Verify that cover of native and nonnative species does not change significantly for each line transect. If cover does change significantly, evaluate which species' (or group of species') cover has changed significantly. Consider whether it is likely that that species' (or group of species') cover would change over the monitoring period. If it is not likely, determine whether the change is because of an error in the data.

4.6.3.4 Comparison to Measurable Objective

For *native vegetative cover*, at MY 5, compare the observed average native cover values to the 40-year measurable objective (75% absolute cover by native trees and 45% absolute cover by native shrubs). Note that an excess of native tree cover can be substituted for native shrub cover if shrub cover is at least 30%. Also note that a total of 85% combined native tree and shrub cover needs to be achieved. If the measurable objective is not met by MY 5, recommend that the Adaptive Management Team evaluate the potential to meet the 40-year measurable objective.

At MY 10 and in subsequent monitoring years, assess whether the *native vegetative cover* measurable objective would be met at year 40, using regression analysis. Recommend remedial actions, if it is likely that the measurable objective will not be met by MY 40. Investigate the cause of insufficient native cover development. Use the line transect native cover data, aerial photograph data, and field observations to determine which areas have insufficient native cover. Use survival, health and vigor, and qualitative assessment data to identify causes of poor native cover development. Recommend replanting and modification of site management if necessary. Alternative species or alternative planting areas may be indicated for replanting.

For *nonnative vegetative cover*, evaluate the relative cover of nonnative trees, nonnative shrubs, and giant reed as a percentage of the total cover of trees and shrubs. If the relative cover of nonnative trees and nonnative shrubs exceeds 15%, recommend removal of nonnative trees and nonnative shrubs to the Adaptive Management Team. If the relative cover of giant reed exceeds 5%, recommend removal of giant reed to the Adaptive Management Team. Recommend where nonnative species should be removed by delineating the area on an aerial photograph.

4.7 Tree Height Indicator

The riparian vegetation tree height indicator represents the range of native tree species' heights in the riparian vegetation mitigation planting areas. The purpose of monitoring this indicator is to determine whether native trees in the riparian vegetation mitigation planting areas are increasing sufficiently in height and to determine the suitability of the planting areas to support planted and naturally recruited riparian tree species. A tall riparian tree canopy provides valuable wildlife habitat. The measurable objective for the tree height indicator is that tree height in the riparian vegetation mitigation planting areas should range from 30 to 60 feet by 40 years following planting (MY 40) (MMP section 4.2.3.7).

4.7.1 Data Collection

4.7.1.1 Permit Requirements

No permits are required for conducting the tree height monitoring described below.

4.7.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E);

- plot stem maps showing individual locations of trees in the sampling plots (appendix F);
- GPS receiver with 1-meter accuracy and/or metal detector to locate the steel rebar monuments that mark sampling plot corners and permanent photo points;
- photo cards showing sampling plot identification numbers and monitoring year;
- high-resolution 35-millimeter digital camera with a 28-millimeter, wide-angle lens;
- 5-foot fixed-height tripod on which the digital camera can be mounted;
- sighting compass;
- 100-foot measuring tape;
- chaining pins (2; to secure ends of measuring tape);
- clinometer;
- stadia rod (a telescoping pole with plainly marked gradations, in feet); and
- data collection form RIP-06 (1 form per sampling plot; appendix D).

4.7.1.3 Schedule

Tree height will be monitored once a year in August or September at 5-year intervals following planting, beginning in MY 5 and continuing through MY 40 (MYs 5, 10, 15, 20, 25, 30, 35, and 40) (chapter 2). Tree height data are collected simultaneously with tree basal area data.

4.7.1.4 Location and Access

The tree height indicator will be monitored at the 20 sampling plots located in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2). These sampling plots are labeled RIP-1–20 (appendix E). Access to sampling plots requires coordination with the SCVWD.

4.7.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor tree height. These steps are described in detail later in this chapter.

To monitor tree height, the monitoring team will

- update the plot stem maps for the sampling plots,

- measure the height of planted and naturally recruited trees in each sampling plot,
- photograph each sampling plot from a fixed photo point and in a fixed direction, and
- record tree height data on data collection form RIP-06.

4.7.1.5.1 Mapping and Documentation

In the Office (monitoring years 10, 15, 20, 25, 30, 35, and 40)

1. Look up the location of the photo point for each sampling plot (table 4-6). Copy the GPS coordinates, location of the photo point relative to the sampling plot, and direction in which the photograph is taken onto the data collection form for each sampling plot.
2. Print the most recent plot stem maps containing the updated information from the previous monitoring year (i.e., location of planted trees that are missing and location of naturally recruited trees greater than 2 inches in diameter at breast height [dbh]).

Table 4-6. Location of Photo Points for Sampling Plots

Sampling Plot Number	Plot Corner of Photo Point	Distance from Plot Corner to Photo Point (feet)	Ground-Level Digital Image Direction (to nearest degree)
1	North	25	141
2	West	25	106
3	West	50	98
4	North	50	156
5	East	50	294
6	West	50	280
7	West	50	58
8	East	50	238
9	East	40	252
10	South	40	356
11	NA	NA	NA
12	North	50	158
13	West	50	321
14	East	50	290
15	North	50	135
16	South	30	20
17	East	25	260
18	North	30	194

Note: NA = not applicable.

In the Field (monitoring years 5, 10, 15, 20, 25, 30, 35, and 40)

3. Begin monitoring at the downstream end of the riparian vegetation mitigation planting area in Segment 1.
4. Locate the sampling plot using the aerial photograph. If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS database of GEMS) or a metal detector to locate the steel rebar monuments that mark the sampling plot corners. Confirm the sampling plot identification number found on the steel rebar monuments.
5. Select a planted or naturally recruited tree within the sampling plot. Use the plot stem map to identify planted trees and previously mapped naturally recruited trees.
6. Verify the location in the sampling plot of each tree shown on the plot stem map.
7. Record the tree's plant identification number on the data collection form.
    a. If the tree is a planted tree or a previously mapped naturally recruited tree, record the identification number from the plot stem map.
    b. If the tree is a new (i.e., not previously mapped) naturally recruited tree that is greater than 2 inches dbh (4.5 feet from the ground surface), assign the tree a plant identification number. Use the following naming convention: 99, water year, and a 3-digit consecutive number for each naturally recruited tree that year. For example, the first naturally recruited tree mapped in WY 2004 would be labeled 9904001.
8. Record the tree's 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Platanus racemosa* is PLRAC]).
9. Update the plot stem map.
    a. If a mapped tree is missing, note its location as "missing" on the plot stem map.
    b. If a naturally recruited tree greater than 2 inches dbh is new (i.e., not previously mapped), map its location on the plot stem map.
10. If a mapped tree is missing, record this information on the data collection form under "Comments."
11. Make a quick visual estimation to determine whether the tree should be measured with a stadia rod or a clinometer. If the tree height is less than 20 feet, use the stadia rod. If the tree height is greater than 20 feet, use the clinometer.

4.7.1.5.1.1 Stadia Rod Method

12. Stand at the base of the tree and extend the stadia rod up until it reaches the top of the tree.

13. Have another person stand away from the tree to confirm that the height of the stadia rod is equal to the height of the tree.
14. Record the stadia rod height reading to nearest 0.1 foot on the data collection form.
15. Go to step 16 below.

4.7.1.5.1.2 Clinometer Method

12. Stand approximately 40 feet from the tree in an area that has a clear view of both the base and top of the tree (figure 4-3).
13. Look through the clinometer at the top of the tree. If the angle from the eye of the observer to the top of the tree is greater than 45°, walk farther away from the tree until the angle is 45° or less (figure 4-3). (As the clinometer reading increases beyond 45°, tree height estimates become exponentially less accurate).

    Note: If the canopy is too dense to view the base and top of the tree simultaneously, the person with the clinometer can try to find a spot where the top of the tree is visible. A second person can stand at the base of the tree and wave something colorful so that the base of the tree or its general location is visible to the person holding the clinometer. If this technique does not work, it is possible to take measurements from two different locations (one where the base of the tree can be seen and the other where the top of the tree can be seen). If this adjustment to the clinometer method occurs, ensure that the distance from the tree is recorded on the data collection form for both locations, both locations are at the same elevation, and both measurements are taken by the same person. This adjusted method is not as reliable because it may be difficult to ensure that both locations are at the same elevation.

14. Record the following information on the data collection form:

    a. the clinometer reading, in degrees, for the base of the tree and for the top of the tree (figure 4-3) and

       Note: The clinometer reading for the base of the tree will in many cases be negative.

    b. the distance between the location where the clinometer readings were taken and the center of the tree at ground level.

4.7.1.5.1.3 Both Methods

16. If the trees in the sampling plot are sufficiently dense, mark each measured tree with chalk, flagging, or some other temporary marker. This technique

will help to prevent multiple measurements of the same tree and will help to ensure that all trees are measured.

17. Be sure that data have been collected for all planted trees and all naturally recruited trees greater than 2 inches dbh.
18. Locate the steel rebar monument that marks the photo point in the sampling plot. If necessary, use the GPS receiver and/or a metal detector. The photo point monument should generally be 50 feet from 1 of the 4 sampling plot monuments (figure 4-4).
19. Place a photo card that includes the sampling plot identification number and monitoring year in the sampling plot, so that the card will be visible in the digital image but will not obscure vegetation in the sampling plot.
20. Photograph the sampling plot from the photo point using a 35- millimeter digital camera with a 28-millimeter wide-angle lens mounted to a 5-foot fixed-height tripod. Using the compass, photograph the sampling plot with the camera facing the direction that is recorded on the data collection form (from table 4-6). Be careful not to aim the camera into the sun, particularly early in the morning or late in the afternoon.

In the Office

21. Download digital images from the digital camera for filing in GEMS.

4.7.1.5.1.4 Immediate Remedial Actions Required

No immediate remedial actions are required for the tree height indicator.

4.7.2 Data Management

Riparian vegetation tree height will be monitored once a year in August or September at 5-year intervals following planting, beginning in MY 5 and continuing through MY 40 (MYs 5, 10, 15, 20, 25, 30, 35, and 40) (chapter 2). Tree height data are collected simultaneously with tree basal area data and recorded on data collection form RIP-06. These indicators are recorded on a per-tree basis. Tree height data are stored in the RDBMS of GEMS.

The plot stem maps will be scanned at a resolution of 150 dots per inch and saved in a compressed format (JPG or TIFF). The resulting digital image file should be named and stored using the conventions described in section 3.4.2.6.1.

4.7.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the tree height indicator:

- tblRipTreeHeightBasalArea (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblRTHPhoto,
- tblRTHPlants,
- tblPlantSpecies,
- tblRTHPlantsBasalDiameters,
- tblRTHTeam, and
- tblMembers.

Figure B-5 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

4.7.2.2 Data Entry

Data from the RIP-06 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.7.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.7.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- photo point direction, and
- 5-letter species code.

4.7.3 Data Analysis and Evaluation

The analysis and evaluation of the tree height monitoring data assesses whether the measurable objective of a height range of 30–60 feet will be met by year 40. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

4.7.3.1 Calculations

Calculate the following variables:

- *tree height measured using the clinometer method* (Husch et al., 1982, 33–37) (no calculation is required for tree heights measured using the stadia rod method);
- *average, minimum, and maximum height of all planted trees in each sampling plot* and *in all sampling plots combined*;
- *average, minimum, and maximum height of all native trees (both planted and naturally recruited) in each sampling plot* and *in all sampling plots combined*; and
- *average, minimum, and maximum height growth rate* (in feet per year) *of all planted trees in all sampling plots combined.*

4.7.3.2 Statistical Analysis Methods

Prepare the following tables:

- *average, minimum, and maximum height of all planted trees* by *sampling plot* (rows) and *monitoring year* (columns) and
- *average, minimum, and maximum height of all native trees (both planted and naturally recruited)* by *sampling plot* (rows) and *monitoring year* (columns).

Prepare the following graphs:

- *average, minimum, and maximum height of all planted trees in the riparian vegetation mitigation planting areas* by *monitoring year;*
- *average, minimum, and maximum height of all native trees (both planted and naturally recruited) in the riparian vegetation mitigation planting areas* by *monitoring year;* and
- *height distribution of native trees (both planted and naturally recruited)* by *monitoring year*, using at least 10 height classes.

At 10 years after planting and every monitoring year thereafter, use regression analysis (Draper and Smith, 1966) to calculate the predicted value for tree height at MY 40. Calculate the predicted value for both planted and naturally recruited tree height. Nonlinear regression is probably the most appropriate model for the relationship between tree height and time because the relationship is probably not linear but instead follows a saturation or sigmoidal relationship.

Evaluate the relationship between tree height and monitoring years and chose a statistical model according to that relationship (Draper and Smith, 1966). A statistical test for determining whether the tree height will be at or above the measurable objective by MY 40 could have very low statistical power for any year until MY 30 because MY 40 will be far beyond the range of measured values. Assess qualitatively the likelihood that the required tree height will be attained.

4.7.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking that tree height is within what can be expected for the tree species at the site based on the professional judgement of a qualified botanist. If unexpected tree height values are found, verify height measurement in the field and correct GEMS, as appropriate.

4.7.3.4 Comparison to Measurable Objective

At year 10, compare the predicted planted tree height based on regression analysis for year 40 with the range of tree heights required to meet the measurable objective by year 40 (30–60 feet; MMP section 4.2.3.7). If the predicted planted tree height is not within that range, recommend remedial actions to the Adaptive Management Team. Remedial actions depend on the causes of growth deficiency. These causes should be investigated based on data from the health and vigor indicator and the qualitative assessment (sections 4.3 and 4.4).

Tree height may vary among trees of a mature stand because of competition among trees. Tree height may also vary between species. If the size distribution and average growth rate of the planted trees indicates that more than 5% of planted trees may not reach 30 feet in height at MY 40, recommend remedial actions to the Adaptive Management Team.

4.8 Tree Basal Area Indicator

The riparian vegetation tree basal area indicator represents the total area of native tree species’ stems measured at breast height (4.5 feet from the ground surface) in the riparian vegetation mitigation planting areas. The purpose of monitoring this indicator is to determine whether the native trees in the planting areas are increasing sufficiently in basal area and to determine the suitability of the planting areas to support planted and naturally recruited riparian tree species. Basal area is a measure of riparian habitat quality. The measurable objective for the tree basal area indicator is that the basal area of native riparian trees will increase over time and that it must be typical for a riparian forest along the Guadalupe River by 40 years following planting (MY 40) (MMP section 4.2.3.8).

4.8.1 Data Collection

4.8.1.1 Permit Requirements

No permits are required for conducting the tree basal area monitoring described below.

4.8.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 20 riparian vegetation mitigation sampling plots (appendix E),
- plot stem maps showing individual locations of trees in both the sampling plots (appendix E) and the reference plots (to be prepared),
- GPS receiver with 1-meter accuracy and/or metal detector to locate the steel rebar monuments that mark sampling plot corners,
- measuring tape (minimum length of 5 feet),
- data collection form RIP-06 (1 form per sampling plot or reference plot; appendix D), and
- 1 of the following (depending on the method to be used):
    - ☐ diameter tape (for the diameter tape method) or
    - ☐ Biltmore stick (for the Biltmore stick method).

4.8.1.3 Schedule

Tree basal area will be monitored once a year in August or September at 5-year intervals following planting, beginning in MY 5 and continuing through MY 40 (MYs 5, 10, 15, 20, 25, 30, 35, and 40) (chapter 2). Tree basal area data will be collected simultaneously with tree height data.

4.8.1.4 Location and Access

The tree basal area indicator will be monitored at the 20 sampling plots located in the riparian vegetation mitigation planting areas in Segments 1A, 1B, and 2, along the west side of the Guadalupe River (figure 1-2). These sampling plots are labeled RIP-1–20 (appendix E). Access to sampling plots requires coordination with the SCVWD.

Tree basal area will also be monitored at reference plots (at future locations to be determined by the Adaptive Management Team).

4.8.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor tree basal area. These steps are described in detail later in this chapter.

To monitor tree basal area, the monitoring team will

- measure the diameter at breast height (i.e., 4.5 feet from the ground surface), using the diameter tape or Biltmore stick method, of all native riparian trees (planted and naturally recruited) that are 2 inches dbh or greater in the sampling and reference plots;
- update the location of trees (both planted and naturally recruited) on the plot stem maps; and
- record all tree basal area data on data collection form RIP-06.

4.8.1.5.1 Mapping and Documentation

Note: The following steps should also be followed to monitor tree basal area at the reference plots. Reference plot data should be recorded on data collection form RIP-06.

In the Office

1. Follow steps 1 and 2 of the tree height indicator (section 4.7.1.5.1) but for the reference plots, rather than the sampling plots.

In the Field

2. Follow steps 3–10 of the tree height indicator but for the reference plots, rather than the sampling plots.
3. Gather tree basal area data using 1 of the methods described below: diameter tape or Biltmore stick.

Note: Tree basal area is monitored for both planted and naturally recruited native trees.

4.8.1.5.1.1 Diameter Tape Method (preferred method)

4. Within the sampling or reference plot, locate a native tree.
5. Determine the location on the stem where the diameter-at-breast-height measurement will be taken (i.e., 4.5 feet from the ground surface).
6. Wrap the diameter tape around the tree at breast height. If the diameter tape is printed on both sides, select the side that has been adjusted for diameter measurements (not the standard measuring side).
7. If the diameter of the tree is 2 inches or greater, record on data collection form RIP-06 the tree's 5-letter species code (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Platanus racemosa* is PLRAC]) and the diameter to the nearest 0.1 inch.

   Note: If the tree has multiple stems, measure all stems greater than 2 inches dbh and sum the measurements.

   If the diameter of the tree is less than 2 inches, move to another native tree.
8. If the trees in the sampling or reference plot are sufficiently dense, mark each measured tree with chalk, flagging, or some other temporary marking. This technique will help to prevent multiple measurements for 1 tree.
9. Repeat steps 4–8 for all native planted trees in the sampling or reference plot.

4.8.1.5.1.2 Biltmore Stick Method

4. Within the sampling or reference plot, locate a native tree.
5. Determine the location on the stem where the diameter-at-breast-height measurement will be taken (i.e., 4.5 feet from the ground surface).
6. Hold the Biltmore stick perpendicular to the stem at arm's length against the tree trunk at breast height. Your eye should be approximately 25 inches from the stick.
7. Align the 0 mark on the Biltmore stick with 1 edge of the tree.
8. Without moving your head, note where the other side of the trunk crosses the stick (figure 4-5).

   Note: If the tree has multiple stems and is greater than 8 feet tall, measure all stems greater than 2 inches dbh and sum the measurements.
9. If the diameter of the tree is 2 inches or greater, record on data collection form RIP-06 the tree's 5-letter species code and its diameter to the nearest 0.1 inch.

   If the diameter of the tree is less than 2 inches, move to another native tree.

10. If the trees in the sampling plot are sufficiently dense, mark each measured tree with chalk, flagging, or some other temporary marking. This technique will help to prevent multiple measurements for 1 tree.
11. Repeat steps 4–10 for all native trees in the sampling plot.

4.8.1.5.1.3 Bitterlich Method

Note: Although identified in the MMP, the Bitterlich method is not recommended to determine basal area in riparian systems for the following reasons. This method is most useful when the stems of trees are plainly visible. Riparian tree species often have multiple branched trunks or have vegetative growth obscuring the stem. In addition, parts of the riparian vegetation mitigation planting areas are too narrow to accurately use the Bitterlich method. Some steel rebar monuments are at the edge of the riparian vegetation mitigation planting areas and will not include trees on all sides, which will result in an estimate of basal area that is lower than the actual basal area in the planting areas. As a result, the Bitterlich method is not described in the IP.

4.8.1.6 Immediate Remedial Actions Required

No immediate remedial actions are required for the tree basal area indicator.

4.8.2 Data Management

Tree basal area data will be collected once every 5 years until year 40 (MYs 5, 10, 15, 20, 25, 30, 35, and 40). Tree basal area data are collected simultaneously with tree height and recorded on data collection form RIP-06. These indicators are recorded on a per-tree basis. Riparian vegetation tree basal area data are stored in the RDBMS of GEMS.

4.8.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the tree basal area indicator:

- tblRipTreeHeightBasalArea (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblRTHPhoto,
- tblRTHPlants,

- tblPlantSpecies,
- tblRTHPlantsBasalDiameters,
- tblRTHTeam, and
- tblMembers.

Figure B-5 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator

4.8.2.1.1 Data Entry

Data from the RIP-06 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

4.8.2.2 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

4.8.2.2.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- photo point direction, and
- 5-letter species code.

4.8.3 Data Analysis and Evaluation

The analysis and evaluation of the tree basal area monitoring data assesses whether the measurable objective of a basal area typical for a riparian forest along the Guadalupe River will be met by MY 40. After 15 years of monitoring, an assessment will be made to determine whether the measurable objective can be expected for MY 40. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

4.8.3.1 Calculations

Calculate the following variables:

- *basal area* (*a*) for each native tree in the sampling plots and each native tree in the reference plots, based on diameter at breast height (d) (i.e., 4.5 feet from the ground surface), where $a = Bd^2/4$;
- *change in basal area from the previous monitoring year* for each native tree in the sampling plots and each native tree in the reference plots;
- *average, minimum, and maximum basal area of all native trees in each sampling plot and all native trees in each reference plot*;
- *average, minimum, and maximum value of the basal area of all native tree species in the riparian vegetation mitigation planting areas as a whole*;
- *average, minimum, and maximum value of the basal area of all native tree species in the reference plots;*
- *average, minimum, and maximum value of the basal area growth rate* (in inches^2 per year) *of each native tree species and all native trees in the riparian vegetation mitigation planting areas as a whole*;
- *average, minimum, and maximum value of the basal area growth rate* (in inches^2 per year) *of each native tree species and all native trees in the reference plots as a whole;*
- *percent total basal area made up of each native tree species in the riparian vegetation mitigation planting areas;*
- *percent total basal area made up of each native tree species in the reference plots*; and
- *basal area per unit land area (in inches^2 per acre) for each sampling plot and reference plot.*

4.8.3.2 Statistical Analysis Methods

Prepare the following tables:

- *average, minimum, and maximum value of the basal area per unit land area of native trees* by *sampling plot* (rows) and *monitoring year* (columns) and
- *average, minimum, and maximum value of the basal area per unit land area of native trees* by *reference plot* (rows) and *monitoring year* (columns).

Prepare the following graphs:

- *average, minimum, and maximum value of the basal area per unit land area of all native tree species in the sampling plots and reference plots*, respectively, versus *monitoring year;*

- *basal area per unit land area distribution of each native tree species in the sampling plots and reference plots, respectively,* versus *monitoring year*, using at least 10 basal area classes;
- *percent total basal area made up of each native tree species in the sampling plots* versus *monitoring year* by species*;* and
- *percent total basal area made up of each native tree species in the reference plots* versus *monitoring year* by *species*.

The MMP requires that a regression analysis (Draper and Smith, 1966) also be prepared in MY 15 and all later monitoring years to confirm that the riparian vegetation mitigation planting areas are progressing toward the 40-year measurable objective. Nonlinear regression is probably the most appropriate model for the relationship because the relationship between tree basal area and time is probably not linear but instead follows a saturation or sigmoidal relationship.

Evaluate the relationship between basal area per unit land area and monitoring years for the sampling plots, and chose a statistical model according to that relationship (Draper and Smith, 1966). A statistical test for determining whether the basal area per unit land area will be within the range expected for a native riparian forest along the Guadalupe River by year 40 could have very low statistical power in any monitoring year until year 30 because MY 40 is far beyond the range of measured values. Assess qualitatively whether the required basal area per unit land area value will be attained.

4.8.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking that basal area for each measured tree is within what can be expected for plants at the site based on the data collected from the previous sampling date and the professional judgment of a qualified botanist. If unexpected basal area values are found, verify the measurement in the field and correct GEMS, as appropriate.

4.8.3.4 Comparison to Measurable Objective

At MY 15, compare the predicted tree basal area per unit land area for the sampling plots for MY 40 to the range of tree basal areas per unit land area required to meet the measurable objective by MY 40 (i.e., the range of tree basal areas in the reference plots). If the predicted tree basal area per unit land area is not within that range, recommend remedial actions to the Adaptive Management Team. Remedial actions depend on the causes of growth deficiency. These causes should be investigated based on data from the health and vigor indicator (section 4.3) and the qualitative assessment (section 4.4).

Chapter 5

SRA Cover

Shaded riverine aquatic cover in Segment 3

5.1 Introduction

Indicators for success of SRA cover mitigation plantings are

- survival,
- health and vigor,
- natural recruitment,
- nonnative vegetative cover,
- shaded stream surface,
- bank stability,
- instream cover, and
- channel bottom stability.

Data collection, data management, and data analysis and evaluation are discussed for each indicator and environmental condition parameter (i.e., qualitative assessment of riparian vegetation mitigation plantings) in later sections of this chapter.

5.1.1 Staff Qualifications

To successfully complete data collection, data management, and data analysis and evaluation requirements associated with the SRA cover indicators and environmental condition parameter, the following minimum qualifications for staff members conducting the work are recommended.

5.1.1.1 Data Collection

Data collection for the survival, health and vigor, qualitative assessment, natural recruitment, nonnative vegetative cover, and shaded stream surface indicators should be performed by staff members with a related 4-year college degree (e.g., botany, ecology, or biology) and 2 years professional experience in botanical field surveys. Specifically, it is suggested that the staff members have experience with

- visual identification of native and nonnative plants to their scientific names, natural recruitment mechanisms, and plant pathogen forms;
- interpretation of aerial photographs;
- use of aerial photographs as a field mapping base; and
- use of a diameter tape, clinometer, and GPS receiver.

Data collection for the instream cover indicator should be performed by staff members with a related 4-year college degree (e.g., fish biology or biology) and 2 years professional experience in fish field surveys. Specifically, it is suggested that the staff members have experience with

- use of various fish and fish habitat sampling techniques,
- interpretation of aerial photographs,
- use of aerial photographs as a field mapping base, and
- use of GPS receiver.

Data collection for the bank stability and channel bottom stability indicators should be performed by staff members with a related 4-year college degree (e.g., geomorphology or geology) and 2 years professional experience in geomorphologic field surveys. Specifically, it is suggested that the staff members have experience with

- evaluation of bank stability,
- interpretation of aerial photographs,
- use of aerial photographs as a field mapping base, and
- use of surveying equipment and GPS receiver.

The data collection methods for most indicators assume that the work will be conducted by a 2-person monitoring team to facilitate safe and efficient data collection. When 2-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

5.1.1.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be performed solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional GIS experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft SQL relational databases.

5.1.1.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in the design and analysis of biological field studies, including regression analysis.

5.2 Survival Indicator

The SRA cover survival indicator represents the number of planted trees and shrubs in the SRA cover mitigation planting areas that are alive. The purpose of monitoring this indicator is to identify occurrences of plant mortality. Mortality of planted trees and shrubs could decrease the quantity or quality of SRA cover habitat in the SRA cover mitigation planting areas. The measurable objective for the SRA cover survival indicator is that a minimum of 17 trees and 10 shrubs per 100 linear feet (lf) must survive for 3 years after planting (MYs 1–3) (MMP section 4.3.4.2).

5.2.1 Data Collection

5.2.1.1 Permit Requirements

No permits are required for conducting the plant survival monitoring described below.

5.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 25 SRA cover sampling plots (appendix E),
- GPS receiver with 1-meter accuracy and/or metal detector to locate the steel rebar monuments that mark the landside sampling plot corners,
- aluminum plant identification tags (approximately 3 by 1 inches) with attachment wire,
- pencil for marking identification tags, and
- data collection form SRA-01 (1 form per sampling plot; appendix D).

5.2.1.3 Schedule

Survival of each planted tree and shrub will be monitored once a year in August or September for 3 years following planting (MYs 1–3) (chapter 2). If in the third year following planting, a sampling plot contains willows with undetermined growth form, that sampling plot will be monitored in the fourth year following planting. This monitoring will better allow the previously undetermined growth form to be identified as either shrub or tree. This identification is important in determining whether the measurable objective for survival of shrubs and trees has been met in that sampling plot. Survival data will be gathered simultaneously with health and vigor data for the first 3 or 4 years following planting and recorded on data collection form SRA-01.

5.2.1.4 Location and Access

The survival indicator will be monitored at the 25 sampling plots located in the SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). These sampling plots are labeled SRA-1–25. Sampling plots SRA-1–13 are located along the Guadalupe River and are numbered sequentially, starting at the downstream end of Reach A (appendix E). Sampling plots SRA-14–25 are located along Guadalupe Creek and are numbered sequentially, starting at the downstream end. Access to sampling plots requires coordination with the SCVWD.

5.2.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor plant survival. These steps are described in detail later in this chapter.

To monitor plant survival, the monitoring team will

- locate all planted trees and shrubs in each sampling plot;
- replace identification tags, if missing or damaged;
- determine a health and vigor numeric rating for each planted tree and shrub, based on foliage, wood, and root crown, as described for the health and vigor indicator (section 5.3.1.5.1); and
- record health and vigor data and survival data on data collection form SRA-01.

5.2.1.5.1 Mapping and Documentation

In the Office

1. Using the data collection forms from the previous year, record the plant identification number and species code on the data collection form for the current year.

In the Field

2. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A, starting at sampling plot SRA-1.
3. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS of GEMS) or a metal detector to locate the steel rebar monuments that mark the landside sampling plot corners.
4. Confirm the sampling plot identification number found on the steel rebar monuments.
5. Locate each planted tree and shrub in the sampling plot. If a planted tree or shrub cannot be located and evidence of installation is observed (e.g., watering basin or stake), enter “0” under “Plant ID Number.” If a planted tree or shrub cannot be located and no evidence of installation is observed, enter “missing” under “Plant ID Number.”

   Note: Planted trees and shrubs taller than 4.5 feet should have an identification tag attached at breast height (4.5 feet from the ground surface) on a lateral stem (figure 4-1). Planted trees and shrubs less than 4.5 feet tall should have an identification tag attached to a lateral stem midway along the plant’s height.

   a. If the plant is missing its identification tag or the identification tag is damaged, go to step 7.

   b. If the identification tag appears to be damaging the plant, move the identification tag to a smaller stem. The identification tag wire should not girdle the plant and should not be placed on the main stem of the plant. Because the main stem will most likely grow faster than lateral stems, avoiding placement of the identification tag here will minimize the chances of girdling the plant.

c. If a new plant has been planted in the same location as an original plant since the last monitoring effort (this step does not apply to natural recruitment), create an identification tag for the new plant that includes the sampling plot identification number, the plant's 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number followed by "R-yy," where "yy" is the year in which the new plant was planted (e.g., "02" for a plant that was planted in 2002) (figure 4-1). Add "R-yy" to the plant's identification number on the data collection form. Record under "Comments" that the plant has been replaced and the date of replacement.

6. On the data collection form

- confirm the plant identification number from the identification tag,
- confirm the 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]) from the identification tag,
- record the plant form (i.e., tree, shrub, or undetermined), and

  Notes: Vines are included in the shrub category (table F-1 of appendix F).

  The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

- record the plant's health and vigor ratings for foliage, wood, and root crown, following the instructions for the health and vigor indicator (section 5.3.1.5.1).

7. If a plant is missing its identification tag or the identification tag is damaged, do the following.

a. Locate the plant by looking for telltale signs of a planted tree or shrub, such as a planting basin and even spacing between plants.

b. If the plant is located, relabel the plant with a new identification tag, including the sampling plot identification number, 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix* *exigua* is SAEXI]), and the plant identification number (use the same plant identification number as before).

If the plant is not located or is determined to be missing, indicate this status on the data collection form.

c. Attach the identification tag to the base of a lateral stem (not the main stem) at breast height (4.5 feet from the ground surface), making sure to secure the tag without girdling the stem and to give the stem room to grow.

d. Record on the data collection form the data indicated in step 6 and indicate under "Comments" that the identification tag has been replaced and the date of replacement.

5.2.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the survival indicator.

5.2.2 Data Management

SRA cover survival data will be collected once a year in August or September for 3 years following planting (MYs 1–3). If in the third year following planting, a sampling plot contains willows with undetermined growth form, that sampling plot will be monitored in the fourth year following planting. This monitoring will better allow the previously undetermined growth form to be identified as either shrub or tree. This identification is important in determining whether the measurable objective for survival of shrubs and trees has been met in that sampling plot. Survival data are recorded together with health and vigor on data collection form SRA-01. These indicators are recorded for each planted tree and shrub in each sampling plot. SRA cover survival data are stored in the RDBMS of GEMS.

5.2.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the survival indicator:

- tblSRASurvivalHealthVigor (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblSSHVPlants,
- tblPlantSpecies,
- tblPlantForm,

- tblRipHealthVigorRating,
- tblSSHVTeam, and
- tblMembers.

Figure B-6 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.2.2.2 Data Entry

Data from the SRA-01 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.2.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.2.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- 5-letter species code,
- plant form (i.e., tree, shrub, or undetermined),
- foliage health and vigor numeric rating,
- wood health and vigor numeric rating, and
- root crown health and vigor numeric rating.

5.2.3 Data Analysis and Evaluation

The analysis and evaluation of the survival monitoring data assesses whether the measurable objective of survival of 17 planted trees and 10 planted shrubs per 100 lf over the entire SRA cover mitigation planting areas will be met for each year for 3 years following planting. In addition, analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met in any of the first 3 years.

Note that vines are included in the shrub category (table F-1 of appendix F) and that the plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub. If in the third year following planting, a sampling plot contains willows with an undetermined growth form, that sampling plot will be monitored in the fourth year following planting to determine whether the measurable objective for survival of shrubs and trees has been met in that sampling plot.

5.2.3.1 Calculations

Calculate the following variables for each sampling plot and for all of the sampling plots for which survival data were collected during the current monitoring year.

- *Percent survival since planting for each planted tree and shrub species and species of undetermined growth form.* For each planted tree and shrub species and each species of undetermined growth form, sum the number of surviving individuals (individuals with a health and vigor rating greater than or equal to 2), divide by the total number of individuals planted for that species, and express as a percentage.
- *Percent survival since planting for all trees.* Sum the number of surviving planted trees (individuals with a health and vigor rating greater than or equal to 2) for all tree species, divide by the total number of trees planted, and express as a percentage.
- *Percent survival since planting for all shrubs.* Sum the number of surviving planted shrubs (individuals with a health and vigor rating greater than or equal to 2) for all shrub species, divide by the total number of shrubs planted, and express as a percentage.
- *Percent survival since planting for all species with undetermined growth form.* Sum the number of surviving planted species with undetermined growth form (individuals with a health and vigor rating greater than or equal to 2) for all species with undetermined growth form, divide by the total number of species with undetermined growth form planted, and express as a percentage.

Calculate the following variables for all of the sampling plots for which survival data were collected during the current monitoring year.

- *Overall tree density (surviving trees per 100 lf).* Sum the number of surviving planted trees for all sampling plots, divide by the combined length of the sampling plots, and multiply by 100. This calculation gives the number of surviving trees per 100 lf.
- *Overall shrub density (surviving shrubs per 100 lf).* Sum the number of surviving planted shrubs for all sampling plots, divide by the combined

length of the sampling plots, and multiply by 100. This calculation gives the number of surviving shrubs per 100 lf.

- *Overall species with undetermined growth form density (surviving species with undetermined growth form per 100 lf).* Sum the number of surviving planted species with an undetermined growth form for all sampling plots, divide by the combined length of the sampling plots, and multiply by 100. This calculation gives the number of surviving species with an undetermined growth form per 100 lf.

5.2.3.2 Statistical Analysis Methods

Prepare the following tables:

- *percent survival since planting for each planted tree and shrub species and each species with undetermined growth form;*
- *percent survival since planting for all trees, shrubs, and species with undetermined growth form in each sampling plot* (rows) by *year since planting* (columns)*;* and
- *percent survival since planting for all trees and all shrubs and species with undetermined growth form for all sampling plots in each monitoring year combined.*

Prepare the following graphs:

- *overall tree density (surviving trees per 100 lf)* versus *time since planting* (show a horizontal line at 17 trees per 100 lf [the minimum target density]),
- *overall shrub density (surviving shrubs per 100 lf)* versus *time since planting* (show a horizontal line at 10 shrubs per 100 lf [the minimum target density]), and
- *overall species with undetermined growth form density (surviving plants per 100 lf)* versus *time since planting*.

5.2.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **The number of surviving plants for each planted species should not be higher than the number of surviving plants present in the previous year.** Check the data collection forms for errors if more plants were recorded alive than in the previous year. A possible explanation for the higher number of surviving plants is that a particular plant received a health and vigor rating of less than 2 in 1 year but more than 2 in the following year because of improved health or vigor of that plant. Additionally, replacement plantings may increase the number of surviving plants for a species. If the higher number of surviving plants cannot be explained by improved health or vigor or replacement planting and if no errors are found on the SRA-01 data collection forms or in data entry, locate the individual planted tree, shrub, or species with undetermined growth form in the field, confirm the survival status of the individual, and correct GEMS, as appropriate.

- **The species identity of each tree, shrub, and species with undetermined growth form should be identical to that in the previous year.** The assigned species identity for a plant may change, for example because a tag was replaced and the wrong species name was put on the tag. Additionally, replacement planting may have occurred, and the replaced species was not the same as the species originally planted. If the species identity for an individual changes between monitoring years, verify the species identity of the individual in the field and correct the plant's identification tag, data collection form SRA-01, and/or GEMS, as appropriate.

5.2.3.4 Comparison to Measurable Objective

Compare the total number of surviving trees and shrubs per 100 lf for each year for 3 years following planting to the measurable objective of a minimum of 17 trees per 100 lf and 10 shrubs per 100 lf. For all 25 sampling plots, which have a total length of 5,000 lf, a minimum of 850 planted trees and 500 planted shrubs should survive each year for 3 years following planting. When all sampling plots are not monitored in the same monitoring year, the total number of planted trees and shrubs that should survive in that monitoring year can be calculated by multiplying the number of sampling plots that are monitored (each sampling plot has a total length of 200 lf) by 34 trees and 20 shrubs. If some willows are classified as having an undetermined growth form, calculate the densities for both cases (i.e., assume undetermined growth form plants to be shrubs and undetermined growth form plants to be trees). Conduct additional analysis if the measurable objective is not met, and use the results of that analysis to recommend specific remedial actions to the Adaptive Management Team. This additional analysis is the same as described for the survival indicator for riparian vegetation (section 4.2.3).

5.3 Health and Vigor Indicator

The SRA cover health and vigor indicator represents health and vigor of the foliage, wood, and root crown of planted trees and shrubs in the SRA cover mitigation planting areas. The purpose of monitoring this indicator is to estimate trends in plant health and to identify sampling plots and other locations in the SRA cover planting areas where the health and vigor of planted trees and shrubs is lacking and where plant mortality may increase. A lack in plants' health and vigor could decrease the quality or quantity of SRA cover habitat in the SRA cover mitigation planting areas. The measurable objective for the SRA cover health and vigor indicator is average health and vigor rating must be greater than or equal to 2 ("fair") on a scale of 0–5 for planted trees and shrubs in each SRA cover sampling plot for 5 years after planting (MYs 1–5) (MMP section 4.3.4.3).

5.3.1 Data Collection

5.3.1.1 Permit Requirements

No permits are required for conducting the health and vigor monitoring described below.

5.3.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 25 SRA cover sampling plots (appendix E),
- GPS receiver with 1-meter accuracy and/or metal detector to locate steel rebar monuments that mark the landside sampling plot corners, and
- data collection form SRA-01 (1 form per sampling plot; appendix D).

5.3.1.3 Schedule

Health and vigor of each planted tree and shrub in a sampling plot will be monitored once a year in August or September for 5 years following planting (MYs 1–5) (chapter 2). Health and vigor data will be collected simultaneously with survival data for the first 3 years following planting and recorded on data collection form SRA-01.

5.3.1.4 Location and Access

The health and vigor indicator will be monitored at 25 SRA cover sampling plots located in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Sampling plots SRA-1–13 are located along the Guadalupe River and are numbered sequentially, starting at the downstream end of Reach A (appendix E). Sampling plots SRA-14–25 are located along Guadalupe Creek and are numbered sequentially, starting at the downstream end. Access to sampling plots requires coordination with the SCVWD.

5.3.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor health and vigor. These steps are described in detail later in this chapter.

To monitor health and vigor, the monitoring team will

- locate all planted trees and shrubs in each sampling plot;
- determine a health and vigor numeric rating for each planted tree and shrub, based on foliage, wood, and root crown health; and
- record health and vigor data on data collection form SRA-01.

5.3.1.5.1 Mapping and Documentation

Note: Steps 1–6 below are the same methods as shown in the corresponding section under "Survival Indicator" (section 5.2.1.5.1). They have been reproduced here for ease of use.

1. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A, starting at sampling plot SRA-1.
2. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use a GPS receiver to locate the coordinates (which can be found in the GIS of GEMS) or a metal detector to locate the steel rebar monuments that mark the landside sampling plot corners.
3. Confirm the sampling plot identification number found on the steel rebar monuments.
4. Locate each planted tree and shrub in the sampling plot. If a planted tree or shrub cannot be located and evidence of installation is observed (e.g., watering basin or stake), enter "0" under "Plant ID Number." If a planted tree or shrub cannot be located and no evidence of installation is observed, enter "missing" under "Plant ID Number."

   Note: Planted trees and shrubs taller than 4.5 feet should have an identification tag attached at breast height (4.5 feet from the ground surface) on a lateral stem (figure 4-1). Planted trees and shrubs less than 4.5 feet tall should have an identification tag attached to a lateral stem midway along the plant's height.

   a. If the plant is missing its identification tag or the identification tag is damaged, go to step 6.

   b. If the identification tag appears to be damaging the plant, move the identification tag to a smaller stem. The identification tag wire should not girdle the plant and should not be placed on the main stem of the plant. Because the main stem will most likely grow faster than lateral stems, avoiding placement of the identification tag here will minimize the chances of girdling the plant.

   c. If a new plant has been planted in the same location as an original plant since the last monitoring effort (this step does not apply to natural recruitment), create an identification tag for the new plant that includes the sampling plot identification number, the plant's 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number followed by "R-yy," where "yy" is the year in which the new plant was planted (e.g., "02" for a plant that was planted in 2002) (figure 4-1). Add "R-yy" to the plant's identification number on the data collection form. Record under "Comments" that the plant has been replaced and the date of replacement.

5. On the data collection form
   - confirm the plant identification number from the identification tag,
   - confirm the 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]) from the identification tag, and
   - record the plant form (i.e., tree, shrub, or undetermined).

   Notes: Vines are included in the shrub category (table F-1 of appendix F).

   The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

6. If a plant is missing its identification tag or the identification tag is damaged, do the following.
   a. Locate the plant by looking for telltale signs of a planted tree or shrub, such as a planting basin and even spacing between plants.
   b. Relabel the plant with a new identification tag, including the sampling plot identification number, 5-letter species code (table F-1 of appendix F) (consists of the first 2 letters of the genus name the first 3 letters of the species name[e.g., the species code for *Salix exigua* is SAEXI]), and the plant identification number (use the same plant identification number as before).
   c. Attach the identification tag to the base of a lateral stem (not the main stem) at breast height (4.5 feet from the ground surface), making sure to secure the tag without girdling the stem and to give the stem room to grow.
   d. Record on the data collection form the data indicated in step 5 and indicate under "Comments" that the identification tag has been replaced and the date of replacement.

7. Follow the steps below to assess and record on data collection form SRA-01 the health and vigor of each planted tree or shrub, based on foliage, wood, and root crown health. It is best to evaluate health and vigor by comparing planted trees and shrubs to normal healthy foliage, wood, and root crowns.

Foliage

a. Look at both the top and underside of individual leaves on all sides of each plant for symptoms of disease. Diseased foliage often contains brown sections, either dieback at the leaf margin or in patches/spots throughout the leaf. Some diseases cause leaves to turn a color that is more red or yellow than normal.

b. Look at leaves on all sides of each plant for signs of browsing by wildlife or damage by insects (e.g., leaves are no longer whole or contain galls).

c. Compare young leaves with mature leaves. Young leaves are usually present near the tips of branches and stems, and mature leaves are usually present near the base of branches and stems. Unhealthy trees and shrubs may produce new leaves that are obviously smaller or more shriveled than mature leaves. Wilted leaves (both new and mature leaves but often most evident on young leaves) are another indicator of poor foliage health.

d. Using the visual observations described above, give the foliage of each planted tree and shrub a numeric rating from 0 to 5, based on the scale in table 5-1.

e. Record the numeric rating on the data collection form.

Table 5-1. Numeric Rating of Foliage Health and Vigor

Numeric Rating	Narrative Rating	Foliage Condition[a]
5	Excellent	Less than 5% of leaves affected by symptoms of poor health
4	Very good	6–25% of leaves affected by symptoms of poor health
3	Good	26–50% of leaves affected by symptoms of poor health
2	Fair	51–75% of leaves affected by symptoms of poor health
1	Poor	Greater than 75% of leaves affected by symptoms of poor health
0	Dead	Foliage is completely dead

[a] After Daubenmire (modified) (1968).

Wood

a. Look at the wood of the main stem and branches of each plant for signs of disease (e.g., cracked or peeling bark, holes in bark, dieback, or accumulated tree sap on the bark surface). Check whether stems or branches are sunburned, usually indicated by cracked or peeling bark on the south-facing side of the plant.

b. Check stems and branches for signs of browsing by wildlife (e.g., cut stems and branches) and damage by insects (e.g., galls or holes bored through the bark into the stem).

c. Evaluate tree structure. Lack of balance (sections of the tree better developed than others) or weak attachment of dominant branches to the main stem(s) is indicative of poor structure.

d. Using the visual observations described above, give the wood of each planted tree and shrub a numeric rating from 0 to 5, based on the scale in table 5-2.

e. Record the numeric rating on the data collection form.

Table 5-2. Numeric Rating of Wood Health and Vigor

Numeric Rating	Narrative Rating	Wood Condition[a]
5	Excellent	Less than 5% of stems and branches affected by symptoms of poor health
4	Very good	5–25% of stems and branches affected by symptoms of poor health
3	Good	26–50% of stems and branches affected by symptoms of poor health
2	Fair	51–75% of stems and branches affected by symptoms of poor health
1	Poor	Greater than 75% of stems and branches affected by symptoms of poor health
0	Dead	Wood is completely dead

[a] After Daubenmire (modified) (1968).

Root Crown

Note: Root crown, as defined here, is the base of the main stem(s) at the ground surface. This definition may not always represent the root crown as defined anatomically.

a. Check the root crown of each plant for signs of disease (e.g., cracked or peeling bark, holes in the bark, or accumulated tree sap on the bark surface).

b. Check the root crown for signs of girdling by wildlife and damage by insects.

c. Using the visual observations described above, give the root crown of each planted tree and shrub a numeric rating from 0 to 5, based on the scale in table 5-3.

d. Record the numeric rating on the data collection form.

Table 5-3. Numeric Rating of Root Crown Health and Vigor

Numeric Rating	Narrative Rating	Root Crown Condition [a]
5	Excellent	Less than 5% of stem base(s) affected by symptoms of poor health
4	Very good	6–25% of stem base(s) affected by symptoms of poor health
3	Good	26–50% of stem base(s) affected by symptoms of poor health
2	Fair	51–75% of stem base(s) affected by symptoms of poor health
1	Poor	Greater than 75% of stem base(s) affected by symptoms of poor health
0	Dead	Root crown is completely dead

[a] After Daubenmire (modified) (1968).

5.3.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the health and vigor indicator.

5.3.2 Data Management

SRA cover health and vigor data will be collected once a year in August or September for 5 years following planting (MYs 1–5). Health and vigor data are recorded together with survival data on data collection form SRA-01. These indicators are recorded for each planted tree and shrub in each sampling plot. SRA cover health and vigor data are stored in the RDBMS of GEMS.

5.3.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the health and vigor indicator:

- tblSRASurvivalHealthVigor (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblSSHVPlants,
- tblPlantSpecies,
- tblPlantForm,
- tblRipHealthVigorRating,
- tblSSHVTeam, and
- tblMembers.

Figure B-6 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.3.2.2 Data Entry

Data from the SRA-01 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.3.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.3.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be entered during data entry:

- sampling plot identification number,
- 5-letter species code,
- plant form (i.e., tree, shrub, or undetermined),
- foliage health and vigor numeric rating,

- wood health and vigor numeric rating, and
- root crown health and vigor numeric rating.

5.3.3 Data Analysis and Evaluation

The analysis and evaluation of the health and vigor monitoring data assesses whether the measurable objective of an average health and vigor rating exceeding "fair" (numeric rating greater or equal to than 2) for each sampling plot will be met in MYs 1–5. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met in any of the first 5 monitoring years.

5.3.3.1 Calculations

Calculate the following variables:

- *average health and vigor numeric rating for each sampling plot,*
- *average health and vigor numeric rating for all sampling plots combined,* and
- *average health and vigor numeric rating for each species over all sampling plots.*

Note: The average health and vigor numeric rating is calculated over all planted trees and shrubs, including obviously dead plants (numeric rating of 0).

5.3.3.2 Statistical Analysis Methods

Prepare the following tables:

- *average, minimum, and maximum health and vigor numeric ratings* by *sampling plot* (rows) and *monitoring year* (columns) *and*
- *average, minimum, and maximum health and vigor numeric ratings for all sampling plots* by *species* (rows) and *monitoring year* (columns).

Prepare the following graph:

- *average, minimum, and maximum health and vigor numeric ratings for all sampling plots* versus *monitoring year* (show a horizontal line at the measurable objective [numeric rating greater than or equal to 2]).

Use the graphs to assess the trend in health and vigor in MYs 1–5, and determine whether the health and vigor of trees and shrubs are increasing or decreasing over time.

5.3.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Health and vigor scores are less than or equal to 5.** If health and vigor numeric ratings greater than 5 occur, locate the individual plants in the field and correct data collection form SRA-01 and GEMS, as appropriate.
- **Large changes in health and vigor numeric ratings between monitoring years.** Compare health and vigor numeric ratings between monitoring years for individual plants (e.g., by tabulating the difference between years), and determine whether unexpected changes occurred that cannot be easily explained. Large value changes are likely only under some catastrophe (e.g., flood event or insect infestation). If such values are found, examine these plants in the field and determine whether the values are correct. Correct data collection form SRA-01 and GEMS, as appropriate.

5.3.3.4 Comparison to Measurable Objective

Compare the average health and vigor numeric rating for each sampling plot to the measurable objective of greater than or equal to 2. Recommend remedial actions if the average value for any sampling plot is less than or equal to 2 in any of the 5 monitoring years.

If the average numeric rating for a sampling plot is less than 2, evaluate the causes of the poor health and vigor. Examine the

- table of *average, minimum, and maximum health and vigor numeric ratings by sampling plot* (rows) and *monitoring year* (columns) to identify sampling plots with low health and vigor numeric ratings and
- table of *average, minimum, and maximum health and vigor numeric ratings for sampling plots* by *species* (rows) and *monitoring year* (columns) to identify species with low health and vigor numeric ratings.

Conduct a field investigation to find the apparent cause of the low health and vigor numeric rating, which may be indicated by soil moisture, soil texture, shade, wildlife browsing, insect damage, evidence of disease, or other factors.

Recommend remedial actions to the Adaptive Management Team if the measurable objective is not met. The causes of low health and vigor numeric ratings determine what remedial action should be taken. For example, recommend fencing/plant protection cages if the cause is wildlife browsing. The cause of disease may not be immediately apparent, and it may be necessary to recommend involving a professional plant pathologist to identify a disease problem and its treatment.

Health and vigor scores may be used to help explain poor performance in other vegetation indicators, such as survival or native vegetative cover.

5.4 Qualitative Assessment

The SRA cover qualitative assessment is an appraisal of the general condition of all the SRA cover mitigation planting areas. The purpose of the qualitative assessment is to determine whether the SRA cover mitigation planting areas are accurately represented by the SRA cover sampling plots and to identify and document problems that may affect the planting areas' ability to provide SRA cover habitat. This assessment is necessary because, for some indicators, only a representative sample of the riparian vegetation mitigation planting areas is monitored. Although the sampling approach is statistically valid, from a site management perspective, it is advantageous to have more extensive data coverage. Problems not identified through monitoring of the SRA cover sampling plots could still decrease the quality or quantity of SRA cover in the SRA cover mitigation planting areas. The SRA cover qualitative assessment is an environmental condition parameter.

5.4.1 Data Collection

5.4.1.1 Permit Requirements

No permits are required for conducting the qualitative assessment monitoring described below.

5.4.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 25 SRA cover sampling plots (appendix E);
- aerial photographs covering the SRA cover mitigation planting areas, printed at a scale of 1 inch = 50 feet (the same photographs used for the nonnative vegetative cover indicator [section 5.6] can be used);
- permanent color pens for marking on the aerial photographs;
- a high-resolution digital camera; and
- data collection form SRA-02 (at least 6 forms; appendix D).

5.4.1.3 Schedule

Monitoring for qualitative assessment will be conducted once a year in August or September for 5 years following planting (MYs 1–5) (chapter 2).

5.4.1.4 Location and Access

The qualitative assessment will be monitored for the SRA cover mitigation planting areas located in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Each of these areas will be monitored separately (appendix E). Access to these areas requires coordination with the SCVWD.

5.4.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to conduct qualitative assessment monitoring. These steps are described in detail later in this chapter.

To conduct qualitative assessment monitoring, the monitoring team will

- assess the SRA cover mitigation planting areas,
- take ground-level digital images of problem areas,
- map problem areas on the aerial photographs, and
- record qualitative assessment data on data collection form SRA-02.

5.4.1.5.1 Mapping and Documentation

In the Field

1. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A.
2. Systematically walk through the planting area, visually examining the entire 15-foot-wide swath until the entire planting area has been observed.
3. Visually evaluate general survival, health and vigor, tree height, cover, species composition, and plant density of all SRA cover mitigation plantings. Identify problems that may affect the planting area’s ability to provide SRA cover habitat (e.g., browsing from wildlife, damage from insects, plant die-off, vandalism, high nonnative cover, or maintenance issues, such as irrigation problems, weed control, and plant protection). Compare vegetation outside the sampling plots with vegetation in the sampling plots to determine whether the sampling plots are representative of the planting area.
4. Fill out separate data collection forms for the SRA cover mitigation planting areas in Reach A; Segments 1, 2 and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (for a total of 6 forms).
5. Record the species for which a problem/potential problem is applicable, a description of the problem, and the specific location of the problem. If the problem does not apply to a species or group of species, record “general”

under “5-Letter Species Code.” If the problem does not have a specific location, record “general” under “Location.”

6. Take ground-level digital images of representative problem areas. Record the corresponding digital image number on the data collection form.
7. Map problem areas on the aerial photographs with a permanent color pen.

In the Office

8. Download digital images from the digital camera for filing in GEMS.

5.4.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the qualitative assessment. However, depending on the problem/potential problem identified, prompt management actions by the SCVWD may be required. The SCVWD will be immediately alerted to such problems/potential problems (e.g., broken irrigation line). The Adaptive Management Team will be alerted about these problems/potential problems as part of the annual mitigation monitoring report that will be prepared for each monitoring year.

5.4.2 Data Management

SRA cover qualitative assessment data will be collected once a year in August or September for 5 years following planting (MYs 1–5). Qualitative assessment data are recorded on data collection form SRA-02. This assessment is recorded for the SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek. Qualitative assessment data are stored in the RDBMS of GEMS.

5.4.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the qualitative assessment:

- tblSRAQualitativeAssess (primary data table),
- tblSRAMitPlantArea,
- tblSQAPlants,
- tblPlantSpecies,
- tblSQATeam, and
- tblMembers.

Figure B-7 in appendix B shows the relationships between the primary data table and the metadata tables for the environmental condition parameter.

5.4.2.2 Data Entry

Data from the SRA-02 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.4.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.4.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- SRA cover mitigation planting area and
- 5-letter species code.

5.4.2.4 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with qualitative assessment points and polygons will be digitized and converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points and polygons will be attributed with 5-letter species code or other vegetation codes and corresponding problem descriptions. All points and polygons from qualitative assessment monitoring for a given year will be included in 2 shapefiles, named “Qualitative_Assessment_<form>_mmmyy,” where “form” is either point or polygon, “mmm” is month (e.g., “aug”), and “yy” is year (e.g., “01”). These shapefiles will also include qualitative assessment monitoring of riparian vegetation mitigation (section 4.4).

5.4.3 Data Analysis and Evaluation

The analysis and evaluation of the qualitative assessment monitoring data assists the Corps, SCVWD, and Adaptive Management Team with the management of the SRA cover mitigation planting areas. In addition, evaluation of the qualitative assessment data may be needed to determine what remedial actions should be recommended if the measurable objectives for other indicators are not met. If the qualitative assessment data indicate that the condition of the vegetation outside the sampling plots is not similar to the condition of the vegetation inside the sampling plots, determine whether the sampling plots are representative of the SRA cover mitigation planting areas by comparing the condition of vegetation inside the sampling plots to the condition of vegetation outside the sampling plots. If the sampling plots are not representative of overall planting area conditions, a note should be made in the annual mitigation monitoring report, and the sampling plot–derived data should be interpreted accordingly.

5.4.3.1 Calculations

No calculations are necessary.

5.4.3.2 Statistical Analysis Methods

No statistical analysis is necessary.

5.4.3.3 Comparison to Measurable Objective

The SRA cover qualitative assessment is an appraisal of the general condition of the SRA cover mitigation planting areas. This appraisal has been requested by the SCVWD to facilitate short-term site management; there is no measurable objective for the SRA cover qualitative assessment. Digitized qualitative assessment points and polygons and ground-level digital images can be compared from monitoring year to monitoring year to track problem areas that may affect the ability of the SRA cover mitigation planting areas to provide SRA cover habitat.

5.5 Natural Recruitment Indicator

The SRA cover natural recruitment indicator represents the level of establishment by natural reproduction of native trees and shrubs within the SRA cover mitigation planting areas. The purpose of monitoring this indicator is to determine whether natural recruitment is occurring within the SRA cover mitigation planting areas. Establishment of native trees and shrubs by natural recruitment indicates sustainability of the mitigation and progress toward a riparian habitat that can perpetuate itself with minimal intervention. The measurable objective for the SRA cover natural recruitment indicator is that natural recruitment of native woody species must be apparent in the mitigation area by 5 years following planting (MY 5) (MMP section 4.3.4.4).

5.5.1 Data Collection

5.5.1.1 Permit Requirements

No permits are required for conducting the natural recruitment monitoring described below.

5.5.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 25 SRA cover sampling plots (appendix E),
- GPS receiver with 1-meter accuracy and/or metal detector to locate steel rebar monuments that mark the landside sampling plot corners, and
- data collection form SRA-03 (1 form per sampling plot; appendix D).

5.5.1.3 Schedule

Natural recruitment will be monitored once in August or September for 5 years following planting (MY 5) (chapter 2).

5.5.1.4 Location and Access

The natural recruitment indicator will be monitored at 25 sampling plots located within SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Sampling plots SRA-1–13 are located along the Guadalupe River and are numbered sequentially, starting at the downstream end of Reach A (appendix E). Sampling plots SRA-14–25 are located along Guadalupe Creek and are numbered sequentially, starting at the downstream end. Access to sampling plots requires coordination with the SCVWD.

5.5.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor natural recruitment. These steps are described in detail later in this chapter.

To monitor natural recruitment, the monitoring team will

- identify native species that have naturally recruited in each sampling plot,

- assess the approximate density of naturally recruited seedlings and vegetative sprouts in each sampling plot,
- determine natural recruitment mechanisms in each sampling plot,
- identify sampling plot–specific characteristics that may influence natural recruitment in each sampling plot, and
- record natural recruitment data on data collection form SRA-03.

5.5.1.5.1 Mapping and Documentation

1. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A, starting at sampling plot SRA-1.
2. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS database of GEMS) or a metal detector to locate the steel rebar monuments that mark the landside sampling plot corners.
3. Confirm the sampling plot identification number found on the steel rebar monuments.
4. Systematically walk through the sampling plot, visually examining the entire 15-foot-wide swath until the entire sampling plot has been observed for native plants that have naturally recruited. Natural recruits may take the form of seedlings or vegetative sprouts. Vegetative sprouts from planted trees and shrubs or other sources should be included as natural recruits only if they are more than 2 feet from the parent plant. Do not include plants that obviously were present prior to the establishment of the sampling plot (e.g., mature trees and shrubs that appear to be much older than the average age of the planted trees and shrubs).
5. Record naturally recruited plant species on the data collection form, using the 5-letter species codes (table F-1 of appendix F) (consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Salix exigua* is SAEXI]).
6. Systematically walk through the sampling plot a second time. On this pass, record the natural recruitment and planted tree and shrub observations described below.

    a. Determine an abundance score for each native species showing signs of natural recruitment (table 5-4). Keep a running tally by native species on the data collection form and use this tally to estimate the total number of individual recruited, native plants by species. Use this tally to determine an abundance score from table 5-4.

Table 5-4. Natural Recruitment Abundance Scores

Abundance Score	Narrative Rating	Number of Natural Recruits (as a range)
1	Rare	1–5
2	Common	6–50
3	Abundant	>50

b. Identify possible recruitment mechanism(s) for each native species, such as vegetative recruitment (sprouts from underground roots attached to the parent plant) or recruitment from seed. If the naturally recruited plants are too old to determine their recruitment mechanism, note it under "General Location/Comments."

c. Note any sampling plot–specific characteristics that may have influenced natural recruitment (or lack of natural recruitment) of each native species. Example characteristics are soil moisture, soil texture, sampling plot disturbance, competition with weeds, and access to sunlight.

d. Describe the general location(s) in the sampling plot of natural recruitment by native species.

e. Look for evidence of seed production (i.e., seeds, seed pods, acorns, fruits, or nuts attached to parent plants or on the ground) on planted trees and shrubs.

5.5.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the natural recruitment indicator.

5.5.2 Data Management

SRA cover natural recruitment data will be collected once in August or September for 5 years following planting (MY 5). Natural recruitment data are recorded on the SRA-03 data collection form. This indicator is recorded for each sampling plot. Natural recruitment data are stored in the RDBMS of GEMS.

5.5.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the natural recruitment indicator:

- tblSRANaturalRecruitment (primary data table),
- tblSamplingPlot,

- tblSamplingPlotType,
- tblSNRPlants,
- tblPlantSpecies,
- tblAbundanceScore,
- tblRecruitMech,
- tblSNRTeam, and
- tblMembers.

Figure B-8 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.5.2.2 Data Entry

Data from the SRA-03 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.5.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.5.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number,
- 5-letter species code,
- abundance score, and
- recruitment mechanism.

5.5.3 Data Analysis and Evaluation

The analysis and evaluation of the natural recruitment monitoring data assesses whether the measurable objective of the occurrence of natural recruitment will be met by MY 5. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

5.5.3.1 Calculations

No calculations are necessary for this indicator.

5.5.3.2 Statistical Analysis Methods

Prepare the following tables.

- *Tree or shrub species that produced or show evidence of producing seedlings or vegetative sprouts* by *sampling plot.* Include species that produced seedlings or vegetative sprouts (rows), the abundance score (1–3) (column), and whether the species produced seedlings (enter an "s") or vegetative sprouts (enter a "v") (column).
- *Characteristics influencing recruitment* by *sampling plot.* Include site-specific factors that appear to affect seedling recruitment or vegetative reproduction. These factors may include dense seedling growth, soil moisture, soil texture, and lack of seed production.
- *Recruitment mechanism* by *sampling plot.* Include all possible recruitment mechanisms, and enter an "x" to indicate which recruitment mechanisms occurred in that sampling plot. Note that there may be more than 1 recruitment mechanism per species in a sampling plot.

5.5.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Abundance scores can only be 1–3.** If abundance scores greater than 3 occur, check the data collection forms. If a data entry error was made, correct GEMS. If no data entry error is found, check the sampling plot during the next field visit and determine what the observation should have been. Correct data collection form SRA-03 and GEMS, as appropriate.

5.5.3.4 Comparison to Measurable Objective

Determine whether natural recruitment occurs for native riparian tree and shrub species. If recruitment does not occur, determine whether any of the recorded characteristics influencing recruitment can explain the lack of reproduction, and recommend remedial actions to the Adaptive Management Team that would modify the site characteristics or otherwise facilitate natural recruitment. In addition, recommend continued monitoring of this indicator if natural recruitment is not observed by MY 5.

5.6 Nonnative Vegetative Cover Indicator

The SRA cover nonnative vegetative cover indicator represents how much of the total vegetative cover in the SRA cover mitigation planting areas is composed of nonnative species. The purpose of monitoring this indicator is to determine the ability of the SRA cover mitigation planting areas to provide native vegetative cover and to minimize relative cover by nonnative vegetation. Monitoring of the nonnative vegetative cover will enable early intervention to reduce the competition by nonnative plants. This intervention is important because competition by nonnative plants can reduce the performance of planted native trees and shrubs, as well as the performance of naturally recruiting native species. The measurable objective for the SRA cover nonnative vegetative cover indicator is that relative cover of less than 15% for combined nonnative tree and shrub species and less than 5% for giant reed (MMP section 4.3.4.5).

In combination or singly, one of 2 methods will be used to collect nonnative vegetative cover data: the visual estimation method or the aerial photograph interpretation method. Use the visual estimation method to collect data for nonnative vegetative cover in MYs 1–5. Use the aerial photograph interpretation method to collect data for nonnative vegetative cover data in MYs 10, 16, 22, 28, 34, and 40.

5.6.1 Data Collection

5.6.1.1 Permit Requirements

No permits are required for conducting the nonnative vegetative cover monitoring described below.

5.6.1.2 List of Equipment

5.6.1.2.1 Visual Estimation Method

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (preferably laminated) covering the SRA cover mitigation planting areas, printed at a scale of 1 inch = 50 feet;
- permanent color pens for marking on the aerial photographs (at least 3 colors); and
- data collection form SRA-04 (at least 6 forms; appendix D).

5.6.1.2.2 Aerial Photograph Interpretation Method

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (preferably laminated) covering the SRA cover mitigation planting areas, printed at a scale of 1 inch = 50 feet, and
- permanent color pens for marking aerial photographs (at least 3 colors).

5.6.1.3 Schedule

Nonnative vegetative cover will be evaluated once a year in August or September for MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2). In MYs 1–5, the visual estimation method will be used to monitor nonnative vegetative cover. In MY 10 and every sixth year thereafter (MYs 10, 16, 22, 28, 34, and 40), the aerial photograph interpretation method will be used to monitor nonnative vegetative cover.

5.6.1.4 Location and Access

The nonnative vegetative cover indicator will be monitored for the SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Each of these sections will be monitored separately (appendix E). Access to these areas requires coordination with the SCVWD.

5.6.1.4.1 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor nonnative vegetative cover. These steps are described in detail later in this chapter.

To monitor nonnative vegetative cover, the monitoring team will

- visually estimate cover of nonnative trees, nonnative shrubs, and giant reed in the SRA cover mitigation planting areas using the visual estimation method (MYs 1–5),
- evaluate cover of nonnative trees, nonnative shrubs, and giant reed using the aerial photograph interpretation method (MYs 10, 16, 22, 28, 34, and 40), and
- record nonnative vegetative cover data on data collection form SRA-04 if using the visual estimation method.

5.6.1.4.2 Mapping and Documentation

5.6.1.4.2.1 Visual Estimation Method (monitoring years 1–5)

1. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A. The nonnative vegetative cover indicator will be monitored at the 6 SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek.
2. Systematically walk through the planting area, visually examining the entire 15-foot-wide swath until the entire planting area has been observed for nonnative vegetative cover. Note apparent areas of concentration of nonnative trees, nonnative shrubs, and giant reed.
3. Map the vegetative cover of nonnative trees, nonnative shrubs, and giant reed in the SRA cover mitigation planting area on the aerial photographs.

    a. Trace the edge of the canopy of all *nonnative* trees with a permanent color pen (use 1 color for all nonnative trees).

    b. Trace the edge of the canopy of all *nonnative* shrubs with a permanent color pen (use 1 color for all nonnative shrubs). Some shrubs may not be visible on the aerial photograph because of dense tree canopy cover; map these shrubs using tree canopies and other recognizable landmarks as references.

    c. Trace the edge of the canopy of all giant reed with a permanent color pen (use 1 color for giant reed).

    Note: It is recommended that nonnative vegetative cover be mapped on laminated digital printouts of the aerial photographs, rather than on the aerial photographs themselves, because there may be limited sets of prints available for all indicators for the entire monitoring year.

4. Visually estimate the percent relative cover contributed by each species of nonnative trees and shrubs and by giant reed, and determine a cover class using the ranges given in table 5-5. Relative cover is the percentage of the total vegetative cover that consists of a particular plant species or vegetation category. Relative cover does NOT include bare ground.

Table 5-5. Cover Class by Visually Estimated Percent Relative Cover

Cover Class	Visually Estimated Relative Cover (%)
1	<5
2	6–15
3	16–50
4	51–75
5	>75

5. Visually estimate the combined percent cover contributed by nonnative trees, nonnative shrubs, and giant reed, and determine both the percentage (or as narrow a percentage range as possible) of nonnative cover and the corresponding cover class (table 5-5).

   Note: Determining a percentage (or narrow percentage range) for the combined cover is important because the percentage ranges used for the cover classes are broad.

6. Fill out separate data collection forms for the SRA cover mitigation planting areas in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek. Record the following data on the data collection form:

   a. 5-letter species code for all nonnative trees, nonnative shrubs, and giant reed observed (the 5-letter species code consists of the first 2 letters of the genus name and the first 3 letters of the species name [e.g., the species code for *Arundo donax* is ARDON]);

   b. specific location of each concentration of nonnative vegetation;

   c. cover class of each species of nonnative trees and shrubs and giant reed; and

   d. percentage and cover class of combined nonnative trees, nonnative shrubs, and giant reed.

5.6.1.4.2.2 Aerial Photograph Interpretation Method (monitoring years 10, 16, 22, 28, 34, and 40)

In the Office

1. Map the vegetative cover of all trees and shrubs in the SRA cover mitigation planting areas on the aerial photographs. Trace the edge of the combined canopy of all trees and shrubs with a permanent color pen (use 1 color for the combined canopy). This step is important to calculate the relative cover of nonnative trees and shrubs and giant reed for comparison to the nonnative vegetative cover measurable objective.

In the Field

2. Map the vegetative cover of nonnative trees and shrubs and giant reed in the SRA cover mitigation planting areas on the aerial photographs.

   a. Trace the edge of the canopy of all nonnative trees with a permanent color pen (use 1 color for all nonnative trees).

   b. Trace the edge of the canopy of all nonnative shrubs with a permanent color pen (use 1 color for all nonnative shrubs). Some shrubs may not be visible on the aerial photograph because of dense tree canopy cover; map these shrubs using tree canopies and other recognizable landmarks as references.

c. Trace the edge of the canopy of all giant reed with a permanent color pen (use 1 color for all giant reed).

Note: It is recommended that nonnative vegetative cover be mapped on laminated digital printouts of the aerial photographs or an acetate overlay on the aerial photographs, rather than on the aerial photographs themselves, because there may be limited sets of prints available for all indicators for the entire monitoring year.

5.6.1.4.3 Immediate Remedial Actions Required

No immediate remedial actions are required for the nonnative vegetative cover indicator.

5.6.2 Data Management

Nonnative vegetative cover will be monitored once a year in August or September for MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40) (chapter 2). In MYs 1–5, the visual estimation method will be used to monitor nonnative vegetative cover. In MY 10 and every sixth year thereafter (MYs 10, 16, 22, 28, 34, and 40), the aerial photograph interpretation method will be used to monitor nonnative vegetative cover.

All nonnative vegetative cover data will be stored in GEMS: data collected with data collection form SRA-04 using the visual estimation method will be entered in the RDBMS, and data collected on aerial photographs using the visual estimation method and aerial photograph interpretation method will be entered in the GIS database.

5.6.2.1 Visual Estimation Method

5.6.2.1.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the nonnative vegetative cover indicator visual estimation method:

- tblSRANonNativeSpecCover (primary data table),
- tblSRAMitPlantArea,
- tblCoverClass,
- tblSNSCPlants,

- tblSNSCTeam, and
- tblMembers.

Figure B-9 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.6.2.1.2 Data Entry

Data from the SRA-04 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.6.2.1.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.6.2.1.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be entered during data entry:

- SRA cover mitigation planting area,
- 5-letter species code,
- cover class, and
- total cover class.

5.6.2.1.4 Data Structure and Entry for Aerial Photographs

In MYs 1–5, nonnative vegetative cover will be evaluated using aerial photographs and GIS. Aerial photographs annotated in the field with nonnative vegetative cover points and polygons will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points and polygons will be attributed with 5-letter species codes. All points and polygons from nonnative vegetative cover monitoring for a given year will be included in 2 shapefiles, named "Nonnative_Tree_and_ Nonnative_Shrub_<form>_mmmyy," where "form" is either point or polygon, "mmm" is month (e.g., "aug"), and "yy" is year (e.g., "01"). These shapefiles will also include nonnative vegetative cover monitoring of riparian vegetation mitigation (section 4.6).

5.6.2.2 Aerial Photograph Interpretation Method

5.6.2.2.1 Data Structure and Entry

Beginning in MY 10 and continuing every sixth year thereafter (MYs 10, 16, 22, 28, 34, and 40), nonnative vegetative cover will be evaluated using aerial photographs and GIS. Aerial photographs annotated in the office with combined cover (i.e., combined native and nonnative) polygons and in the field with nonnative vegetative cover polygons will be converted into GIS data by a GIS specialist. GIS layers will be created using the aerial photographs as the base map. The digitized polygons will be attributed with vegetation categories (i.e., nonnative tree, nonnative shrub, or giant reed). All polygons from nonnative vegetative cover monitoring for a given year will be included in 4 GIS layers, named "SRA_nonnative_cover <vegetation category> mmmyy," where "vegetation category" is combined cover, nonnative tree, nonnative shrub, or giant reed; "mmm" is month (e.g., "aug"); and "yy" is year (e.g., "01").

Using GIS query capabilities, the GIS analyst will calculate cover values for the SRA cover mitigation planting areas.

5.6.3 Data Analysis and Evaluation

The analysis and evaluation of the nonnative vegetative cover monitoring data assesses whether the measurable objective of less than 5% giant reed cover and less than 15% combined nonnative tree and shrub cover will be met in MYs 1–5 and 10 and every sixth year thereafter through MY 40 (MYs 16, 22, 28, 34, and 40). In addition, areas where removal of nonnative species needs to occur, if any, should be identified.

5.6.3.1 Calculations

5.6.3.1.1 Visual Estimation Method

No calculations are necessary.

5.6.3.1.2 Aerial Photograph Interpretation Method

Calculate the *relative percent cover for nonnative trees and shrubs* and *relative percent cover for giant reed* by summing the areas of all polygons of each nonnative vegetation category in the SRA cover mitigation planting areas and dividing the sum by the total area of all vegetation polygons in the SRA cover mitigation planting areas.

Note: Do not count twice the overlapping nonnative tree and shrub cover or overlapping giant reed cover when summing the total area of all nonnative trees and shrubs or giant reed.

5.6.3.2 Statistical Analysis Methods

5.6.3.2.1 Visual Estimation Method

Prepare the following tables:

- *average relative nonnative tree and shrub species (including giant reed) cover class* (row) by *monitoring year* (column) and
- *average relative giant reed cover class* (row) by *monitoring year* (column).

5.6.3.2.2 Aerial Photograph Interpretation Method

Prepare the following tables:

- *average relative nonnative tree and shrub cover value* (row) by *monitoring year* (column) and
- *average relative giant reed cover value* (row) by *monitoring year* (column).

5.6.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **All nonnative cover values are between 0 and 100%.** Examine the range of nonnative cover values and verify that cover values do not exceed 100%. If cover values exceed 100%, check the aerial photographs for mapping errors and the GIS database for digitizing errors. If necessary, examine the SRA cover mitigation planting areas in the field and determine whether the nonnative vegetative cover mapping is correct. Correct the GIS database, as appropriate.
- **Species composition does not change significantly between years.** The relative cover of nonnative species may vary slightly between years because of measurement error; however, barring removal of nonnative species or other sources of mortality, relative cover is not expected to change significantly between years for nonnative trees and shrubs and giant reed. Verify that relative cover of nonnative species does not change significantly. If relative cover does change significantly, evaluate which species' (or group of species') cover has changed significantly. Consider whether it is likely that that species' (or group of species') cover would change over the monitoring period. If it is not likely, determine whether the change is because of an error in the data. Check the aerial photographs for mapping errors and the GIS database for digitizing errors. If necessary, examine the SRA cover mitigation planting areas in the field and determine whether the nonnative vegetative cover mapping is correct. Correct the GIS database, as appropriate.

5.6.3.4 Comparison to Measurable Objective

Evaluate the relative cover of nonnative trees and shrubs and giant reed as a percentage of the total cover of native and nonnative trees and shrubs. If the relative cover of nonnative trees and shrubs exceeds 15%, recommend removal of nonnative species to the Adaptive Management Team. If the relative cover of giant reed exceeds 5%, recommend removal of giant reed to the Adaptive Management Team. Recommend where nonnative trees, nonnative shrubs, and giant reed should be removed by delineating the area on an aerial photograph.

5.7 Shaded Stream Surface Indicator

The SRA cover shaded stream surface indicator represents the percentage of the total stream surface area shaded by trees and shrubs during midday. The purpose of monitoring this indicator is to measure the establishment of overhead SRA cover relative to conditions that existed prior to Project implementation. Overhead SRA cover provides habitat for fish and other aquatic organisms and minimizes potential increases in water temperature. The measurable objective for the shaded stream surface indicator is that trees and shrubs must shade at least 45%, 41%, 64%, 45%, and 58% of the total stream surface in Reach A; Segments 1, 2, and 3; Woz Way to Park Avenue Bypass; and Guadalupe Creek, respectively, by 40 years after planting (MY 40). At least 85% of the streambank must be shaded by MY 40. The percentage of total stream surface area shaded must increase toward the measurable objective by 9 years after planting (MY 9) (MMP section 4.3.4.6).

5.7.1 Data Collection

5.7.1.1 Permit Requirements

No permits are required for conducting the shaded stream surface monitoring described below.

5.7.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs showing the location of the 25 SRA cover sampling plots (appendix E);
- aerial photographs (preferably laminated) of the SRA cover mitigation planting areas, printed at a scale of 1 inch = 50 feet;
- 100-foot measuring tape;
- chaining pins (2; to secure ends of measuring tape);

- permanent color pens for marking on the aerial photographs;
- GPS receiver with 1-meter accuracy and/or a metal detector to locate the steel rebar monuments that mark the landside sampling plot corners;
- chest waders and life jacket (for 1 team member); and
- data collection form SRA-05 (at least 25 copies; appendix D).

5.7.1.3 Schedule

Shaded stream surface will be evaluated once a year in September or October during the following years: immediately following planting and at 3-year intervals through MY 40 (i.e., MYs 0, 3, 6, 9,12, 15, 18, 21, 24, 27, 30, 33, 36, 39, and 40).

5.7.1.4 Location and Access

The shaded stream surface indicator will be monitored at the 25 SRA cover sampling plots located in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Sampling plots SRA-1–13 are located along the Guadalupe River and are numbered sequentially, starting at the downstream end of Reach A (appendix E). Sampling plots SRA-14–25 are located along Guadalupe Creek and are numbered sequentially, starting at the downstream end. Access to sampling plots requires coordination with the SCVWD.

5.7.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor the area of shaded stream surface. These steps are described in detail later in this chapter.

To monitor the area of shaded stream surface, the monitoring team will

- mark on aerial photographs the boundaries of riparian tree and shrub canopies (both native and nonnative) that hang over the water surface, adjacent to sampling plots,
- confirm wetted channel width measurements, and
- record shaded stream surface data on data collection form SRA-05.

5.7.1.5.1 Mapping and Documentation

1. Begin monitoring at the downstream end of the SRA cover mitigation planting areas in Reach A, starting at sampling plot SRA-1.

2. Locate the sampling plot using the aerial photograph (appendix E). If necessary, use either a GPS receiver to locate the coordinates (which can be found in the GIS database of GEMS) or a metal detector to locate the steel rebar monuments that mark the landside sampling plot corners.
3. Confirm the sampling plot identification number found on the steel rebar monuments.
4. Using features visible on the ground and on the aerial photographs as a reference, verify the approximate wetted channel boundaries on the 1:50-scale aerial photographs.
5. Measure the wetted channel width at 50-foot intervals adjacent to the sampling plot.

    a. Start at the downstream end of the sampling plot.

    b. Extend the measuring tape perpendicularly across the channel, using chaining pins to secure the tape at the left water's edge (LWE) and the right water's edge (RWE).

    Note: Right and left banks are relative to a person facing downstream (Armantrout, 1998).

    c. Measure the wetted channel width at the downstream end of the sampling plot (beginning of sampling plot), at the upstream end of the sampling plot (end of sampling plot), and at least 1 additional location for each 50 feet of stream length along the sampling plot (the measurements should be taken at evenly spaced intervals along the length of the sampling plot). Some sampling plots are divided into noncontinuous sections. Wetted channel width measurements for these sampling plot sections follow the same protocol as for a complete sampling plot. For example, a 200-foot sampling plot section would have 5 width measurements: 1 each at the beginning and end and additional measurements at 50 feet, 100 feet, and 150 feet upstream from the downstream end of the sampling plot. A 130-foot sampling plot section would have 4 width measurements, 1 each at the beginning and end and additional measurements at 43 feet and 86 feet upstream from the downstream end of the sampling plot.

    d. Record the measurements (to the nearest 0.2 foot) on the data collection form. Also record the distance from the sampling plot's beginning point to the point where a measurement is taken.

6. Using features visible on the ground and on the aerial photographs as a reference, verify the approximate stream edges for the channel between the 50-foot-interval measurements. Correct the stream edge location, as necessary, on the aerial photographs.
7. Using features visible on the ground and on the aerial photographs as reference points, mark on the aerial photographs the boundaries of riparian tree and shrub canopies (both native and nonnative) that overhang the water surface adjacent to each of the sampling plots. Vegetation overhanging the

water surface from both sides of the channel, not just from the sampling plot, should be mapped.

Note: It is recommended that shaded stream surface be mapped on laminated digital printouts of the aerial photographs or an acetate overlay on the aerial photographs, rather than on the aerial photographs themselves, because there may be limited sets of prints available for all indicators for the entire monitoring year.

5.7.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the shade stream surface indicator.

5.7.2 Data Management

Shaded stream surface data will be collected once a year in September or October immediately following planting and at 3-year intervals through MY 40 (i.e., MYs 0, 3, 6, 9,12, 15, 18, 21, 24, 27, 30, 33, 36, 39, and 40). Shaded stream surface data are recorded for each SRA cover sampling plot. Shaded stream surface data are recorded on aerial photographs and data collection form SRA-05. SRA cover shaded stream surface data are stored in GEMS: numeric data are stored in the RDBMS and spatial data are stored in the GIS database.

5.7.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the shaded stream surface indicator:

- tblSRAShadedStreamSurface (primary data table),
- tblSamplingPlot,
- tblSamplingPlotType,
- tblStreamSegment,
- tblSSSMeasure,
- tblSSSTeam, and
- tblMembers.

Figure B-10 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.7.2.2 Data Entry

Data from the SRA-05 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.7.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.7.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- sampling plot identification number and
- stream segment.

5.7.2.3.2 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with shaded stream surface polygons will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized polygons will be attributed with the sampling plot identification number. All polygons from shaded stream surface monitoring for a given year will be included in 1 shapefile, named “SRA_Shaded_Stream_Surface_ mmmyy,” where “mmm” is month (e.g., “aug”) and “yy” is year (e.g., “01”).

Using GIS query capabilities, the GIS specialist will calculate shaded stream surface area (i.e., acres and percentage of wetted channel) for each sampling plot. These values will be stored in GEMS. The wetted channel width values collected in the field will be used to adjust the wetted channel width in the GIS database.

5.7.3 Data Analysis and Evaluation

The analysis and evaluation of the shaded stream surface indictor assesses whether the measurable objective of riparian trees and shrubs shading at least 45, 41, 64, 45, and 58% of the total stream surface in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek, respectively, is met.

5.7.3.1 Calculations

Calculate the following variables for each stream segment adjacent to a sampling plot.

- *Percent stream surface shaded.* Divide the total stream surface area by the shaded stream surface area and express as a percentage.
- *Average percent stream surface shaded.* Calculated independently for Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek. The average will include the percentage from all sampling plots within each of these stream segments.

5.7.3.2 Statistical Analysis Methods

Perform a regression analysis in MY 6 and every monitoring increment thereafter. Using the regression of shade calculated for year 9, estimate the shade expected at MY 40 (MMP section 4.3.4.6).

Prepare the following graph.

- *Average percent stream surface shaded* calculated from the regression equation (*percent stream surface shaded* by *year*). Show the measurable objective for each stream segment shown as a horizontal line.

5.7.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Total bank length for each sampling plot should not exceed 200 feet.** Confirm that the total bank length for each sampling plot does not exceed 200 feet. Some sampling plots are divided into noncontinuous sections; confirm that the total length of the noncontinuous sections does not exceed 200 feet. If total bank length exceeds 200 feet, check for errors on data collection form SRA-05 and for errors in data entry. If necessary, examine the sampling plot in the field, and determine whether the bank length values are correct. Correct GEMS, as appropriate.
- **All shaded stream surface area values are between 0 and 100%.** Examine the range of shaded stream surface area values, and verify that surface area values are between 0 and 100%. If surface area values are not between 0 and 100%, check the aerial photographs for mapping errors and the GIS database for digitizing errors. If necessary, examine the sampling plot in the field, and determine whether the surface area mapping is correct. Correct the GIS database, as appropriate.

5.7.3.4 Comparison to Measurable Objective

Compare the *average percent stream surface shaded* for Reach A; Segments 1, 2, and 3 (i.e., Segment 3A and Woz Way to Park Avenue Bypass); and Guadalupe Creek to the respective measurable objective: 45, 41, 64, 45, and 58%.

Note the progress toward the measurable objective illustrated by regression analysis, and discuss the potential causes of lower or higher shade values.

5.8 Bank Stability Indicator

The SRA cover bank stability indicator represents the percentage of the natural bank that has stable groundcover. Stable ground cover includes rooted trees, shrubs, herbaceous plants, and naturally occurring rocky substrates (i.e., boulders, bedrock, and cobble/boulder aggregates that are combined to form a stable mass). The purpose of monitoring this indicator is to identify soil erosion that may result from Project features or operation. Increased soil erosion could adversely affect fish habitat, including direct effects on fish survival, such as smothering of eggs, and effects on food availability. The measurable objective for the bank stability indicator is that stable ground cover must be present along at least 75% of the streambank in the natural channel segments of Reach A; Segments 1, 2, 3A, and 3B; Woz Way to Park Avenue Bypass; and Guadalupe Creek (MMP section 4.3.4.7).

5.8.1 Data Collection

5.8.1.1 Permit Requirements

No permits are required for conducting the bank stability monitoring described below.

5.8.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- same aerial photographs as used for shaded stream surface indicator monitoring (section 5.7) (MYs 1–4, 7, and 10),
- GPS receiver with 1-meter accuracy,
- 100-foot measuring tape (MYs 1–4, 7, and 10),
- chaining pins (2; to secure ends of measuring tape),
- chest waders and life jacket (for 1 team member),

- float tube (to assist with moving through deep sections of channel and carrying equipment),
- large clipboard, and
- data collection form SRA-06 (several forms; appendix D).

5.8.1.3 Schedule

Bank stability will be evaluated once a year between April and June during MYs 1–4, 7, and 10 following Project construction. Photographs will be taken of postconstruction bank condition within 60 days following construction.

5.8.1.4 Location and Access

The bank stability indicator will be monitored in all natural bank segments in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

5.8.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor bank stability. These steps are described in detail later in this chapter.

To monitor bank stability, the monitoring team will

- assess banks in all natural bank segments for stability and erosion, and record bank stability on data collection form SRA-06 (MYs 1–4, 7, and 10).

5.8.1.5.1 Mapping and Documentation

The terms defined in table 5-6 will be used on data collection form SRA-06 to describe observed bank stability conditions.

Table 5-6. Terms Used to Describe Bank Stability Conditions [a]

Category	Term	Definition
Banks	Stable bank	Has 75% or more cover of live plants and/or other stability elements that are not easily eroded and has no instability elements
	Potentially unstable bank	Has 75% or more cover but with 1 or more instability element(s)[b]
	Unstable bank	Has less than 75% cover of live plants and/or other stability elements and/or 1 or more instability element(s) (unstable banks are often bare or nearly bare banks composed of noncohesive soil that is susceptible to fluvial erosion; particle size may vary depending on bank material)
Stability elements	Live plants	Perennial herbaceous species, such as grasses, sedges, rushes; woody shrubs, such as willows; broadleaf trees, such as cottonwood and alder; conifer trees; and plant roots that are on or near the surface of the bank and provide substantial binding strength to the bank material
	Rock	Boulders, bedrock, and cobble/boulder aggregates that are combined to form a stable mass
	Downed wood	Logs firmly embedded in banks
	Erosion-resistant soil	Hardened conglomerate or cohesive clay/silt banks
Instability elements	Bank height	Moderately high to high bank height relative to surrounding banks
	Fracturing, blocking, or slumping	Cracks near the top of the bank, slumping banks, and blocks of soil/plant material that have fallen off or slid down the bank
	Mass movement	Bank failure from landslides and gravity erosion of oversteepened bank slopes
	Undercutting	Frequent or continuous scour; significant to severe undercutting

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[a] Based on definitions of bank conditions in the U.S. Forest Service Region 5 *Stream Condition Inventory Guidebook* (U.S. Department of Agriculture Forest Service 1998).

[b] Exception: Bank will be classified as stable if bank height is the only instability element present.

Bank Stability Monitoring (monitoring years 1–4, 7, and 10)

In the Office

1. Determine the total length of each stream segment (Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek), using the aerial photographs in appendix E.

In the Field

2. Begin monitoring at the downstream end of the stream segment.

3. Record the stream segment name and bank length on the data collection form.
4. Walk upstream along the bank.
5. Examine banks in the natural segments of the stream reaches. Banks extend from the water's edge to the break in slope between the steep-sloping bank and low-sloping or horizontal terrace surface above any lower floodplain surfaces (figure 5-1). This break in slope is subsequently referred to as *top of the bank*. In Segments 1–3, a low floodplain may not be present.
6. Locate unstable or potentially unstable bank segments that are 10 or more feet long.

   Note: Data will be collected only for unstable or potentially unstable bank segments. Data for stable bank segments will be derived from calculations completed in the office.

7. Record the bank segment identification number (in numerical order) on the data collection form. Use the following alphanumeric naming convention to label each bank segment: water year, 4-letter abbreviation for bank stability, and a consecutive number for each bank segment, beginning with 001. For example, the first unstable or potentially unstable bank segment for WY 2001 would be labeled 01-BANK-001.
8. Record whether the unstable or potentially unstable bank segment occurs on the right or left bank.

   Note: Right and left banks are relative to a person facing downstream (Armantrout, 1998).

9. Record the vertical and horizontal distance from the water's edge to the top of the bank. Vertical distance is measured perpendicular to the water surface from the water's edge to the top of the bank (i.e., bank height). Horizontal distance is measured parallel to the water surface from the water's edge to the top of the bank (i.e., map distance).
10. Record the bank stability as potentially unstable or unstable (table 5-6).
11. Take a GPS reading at the downstream end of the bank segment. If necessary, traverse perpendicular to the origin of the unstable or potentially unstable segment to record the GPS reading. **DO NOT stand on or near unstable or potentially unstable banks.**
12. Measure the length (parallel to the stream channel) of the potentially unstable or unstable bank segment, taking measurements at the widest point (figure 5-2). Record the measurement to the nearest 5 feet.
13. Describe the instability elements under "Comments."
14. Map potentially unstable and unstable bank segments on the aerial photographs. Label each bank segment with its identification number (step 7).

In the Office

15. Download the GPS data.

5.8.1.5.2 Immediate Remedial Actions Required

Alert the SCVWD of unstable or potentially unstable bank segments that potentially threaten infrastructure and mitigation elements, including vegetation or stream channel structure.

5.8.2 Data Management

SRA cover bank stability data will be collected once a year in April, May, or June for 4 years following Project construction and at 3-year intervals thereafter until MY 10 (MYs 1–4, 7, and 10). Bank stability data are recorded on the SRA-06 data collection form. This indicator is recorded for all natural bank segments. Bank stability data are stored in the RDBMS of GEMS.

5.8.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the bank stability indicator.

- tblSRABankStability (primary data table),
- tblStreamSegment,
- tblSBSBankMeasure,
- tblBanKType,
- tblSBSTeam, and
- tblMembers.

Figure B-11 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

Note: Bank stability was monitored in WY 2001 using the "plot" method, in which bank stability was monitored only adjacent to SRA cover sampling plots. Based on Adaptive Management Team recommendations in the WY 2001 and 2002 MMRs (Jones & Stokes, 2002 and 2003), effective WY 2003, bank stability will be monitored using the "survey" method, in which all natural banks in Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek are monitored for stability. The new survey method required that the data collection form be changed. However, to avoid losing data collected in WY 2001 and 2002, the same tables in GEMS were used to store the data for both methods.

> *The primary data tables for the bank stability indicator were changed as little as possible between the old plot method and the new survey method. A few fields were added to the tables (e.g., side of bank). The data format for some fields changed slightly (e.g., stream segment is now entered into the field in which SRA cover sampling plot was entered before). The data entry forms were labeled with the descriptions found on the survey method data collection forms. Though the data collected using the plot method in WY 2001 and WY 2002 can still be seen through the GUI because the primary data tables still hold all of the plot method data, the data entry form no longer looks like the data collection form for the plot method.*

5.8.2.2 Data Entry

Data from the SRA-06 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.8.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the database software.

5.8.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values are entered during data entry:

- stream segment,
- side of bank, and
- bank type.

5.8.2.4 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with unstable and potentially unstable bank segments will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized segments will be attributed with bank segment identification numbers. All lines from bank stability monitoring for a given year will be included in 1 shapefile, named “SRA_Bank_Stability_mmmyy,” where “mmm” is month (e.g., “may”) and “yy” is year (e.g., “01”).

5.8.3 Data Analysis and Evaluation

The analysis and evaluation of the bank stability monitoring data assesses whether the measurable objective of stable ground cover along at least 75% of the natural bank throughout Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek will be met in MYs 1–4, 7, and 10.

5.8.3.1 Calculations

Calculate the following variables independently for each stream segment (i.e., Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; and Guadalupe Creek) and for all stream segments combined.

- *Percent total natural bank length that is unstable.* Sum the total length of unstable bank, divide this number by the total natural bank length, and express as a percentage.
- *Percent total natural bank length that is potentially unstable.* Sum the total length of potentially unstable bank, divide this number by the total natural bank length, and express as a percentage.
- *Percent total natural bank length that is stable.* Sum the total length of unstable bank, subtract this number from the total natural bank length, divide the difference by the total natural bank length, and express as a percentage.

Notes: The total natural bank length for each stream segment is calculated by multiplying the length of the stream segment that has natural banks by 2, accounting for the natural bank on each side of the stream.

The total natural bank length that is stable includes potentially unstable bank lengths.

5.8.3.2 Statistical Analysis Methods

Prepare the following graph:

- *percent total bank length that is stable*, *percent total bank length that is unstable*, and *percent total bank length that is potentially unstable in each stream segment* (i.e., Reach A; Segments 1, 2, 3A, and 3B; Woz Way to Park Avenue Bypass; and Guadalupe Creek) and *all stream segments combined* versus *monitoring year*.

5.8.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Total unstable and potentially unstable bank length for each stream segment should not exceed the total natural bank length of the stream segment.** Confirm that the total unstable and potentially unstable bank length for each stream segment does not exceed the total natural bank length for that stream segment. If total unstable and potentially unstable bank length for a stream segment exceeds the total natural bank length for that stream segment, check for errors on data collection form SRA-06 and for errors in data entry. The total natural bank length for each stream segment is calculated by multiplying the length of the stream segment that has natural banks by 2 to account for the natural bank on each side of the stream. If necessary, examine the stream segments in the field, and determine whether the bank length values are correct.

5.8.3.4 Comparison to Measurable Objective

Compare the percentage of stable bank for Reach A; Segments 1, 2, and 3A; Woz Way to Park Avenue Bypass; Guadalupe Creek; and all stream segments combined to the measurable objective of 75%. If bank instability has increased relative to initial postproject surveys in 2001 and the increase (when considered in context with the past 3–5 years of data) indicates a trend or permanent change in conditions, identify the potential cause of the instability. Based on variability in bank stability over the previous 3–5 years and over the entire monitoring period, discuss recommendations for remedial actions and future monitoring needs.

5.9 Instream Cover Indicator

The SRA cover instream cover indicator represents the proportion of the stream bottom that is covered by undercut banks with an undercut width greater than 4 inches; roots, logs, and debris piles greater than 155 square inches, or 1.1 square feet, in surface area; and boulders and rocks greater than 8 inches in diameter. The purpose of monitoring this indicator is to determine whether enough instream cover is present to provide habitat for fish species. Instream cover is an important component of SRA cover and steelhead and Chinook salmon habitat. The measurable objective for the instream cover indicator within Reach A; Segments 1, 2, 3A, and 3B; Woz Way to Park Avenue Bypass; and Guadalupe Creek must be greater than 10% by 10 years following Project construction (i.e., MY 10) (MMP section 4.3.4.8).

5.9.1 Data Collection

5.9.1.1 Permit Requirements

No permits are required for conducting the instream cover monitoring described below.

5.9.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- same aerial photographs as used for the rearing habitat diversity monitoring;
- 100-foot measuring tape;
- chaining pins (2; to secure the measuring tape);
- Secchi tube;
- permanent color pens for marking on the aerial photographs;
- pin flags (4);
- chest waders and life jacket (for all team members);
- float tube;
- stadia rod;
- wading staff (for stability and identifying deep water); and
- data collection form SRA-07 (several forms; appendix D).

5.9.1.3 Schedule

Instream cover monitoring will be conducted once a year between June and October. The first monitoring activity will be conducted immediately after Project construction (MY 0). Subsequent monitoring will be conducted at 3-year intervals through MY 10 (MYs 3, 6, 9, and 10).

Note: Data for the rearing habitat diversity indicator (section 8.4.1) must be collected before instream cover can be monitored.

5.9.1.4 Location and Access

Instream cover will be monitored at 100 randomly selected transect bands in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

5.9.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor instream cover. These steps are described in detail later in this chapter.

To monitor instream cover, the monitoring team will

- establish randomly selected, 10-foot-wide transect bands perpendicular to the stream flow that span the entire wetted width of the channel;
- measure instream cover in each transect band;
- determine the proportion of each transect band with instream cover; and
- record instream cover data on data collection form SRA-07.

5.9.1.5.1 Mapping and Documentation

In the Office

1. Determine the proportion of total stream length represented by pool, riffle, and run habitat types within each stream segment (i.e., Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek). These habitat type data were collected for the rearing habitat diversity indicator (section 8.4).
2. Determine the number of transect bands to be established in each habitat type for each stream segment, using the proportion of total stream segment length represented by pool, riffle, and run and the number of transect bands allocated to that stream segment. For example, if the number of transect bands totals 10 for a particular stream segment and the stream segment is composed of 4,000 feet of pool, 4,000 feet of riffle, and 2,000 feet of run, 4 transect bands will be placed in pools, 4 in riffles, and 2 in runs. The number of transect bands allocated to each stream segment for instream cover measurements, based on a total of 100 transect bands, is presented in table 5-7.

Table 5-7. Number of Transect Bands in Each Stream Segment Based on Length of Segment in Water Year 2001

Stream Segment	Number of Transect Bands
Reach A	22
Segment 1	5
Segment 2	14
Segment 3A	8
Segment 3B	11
Segment 3C	5
Woz Way to Park Avenue Bypass	6
Guadalupe Creek	29

3. Select random numbers for each habitat type. Continuing with the above example, random numbers for pools will be selected from 1 to 4,000. Each transect band encompasses 10 feet of stream length: 5 feet downstream and 5 feet upstream of the randomly selected point. Beginning at the downstream end of Reach A, the location of the transect band is determined from the cumulative length of each habitat type within the stream segment. Assume the first random number for pools is 168. Also assume that the first pool is 30 feet long, the second pool is 50 feet long, the third pool is 60 feet long, the fourth pool is 20 feet long, and the fifth pool is 35 feet long. The first transect band would be located in the fifth pool at approximately 8 feet from the downstream end of the pool. If the random location of a transect band results in a transect band that overlaps into an adjacent habitat type, adjust the transect band location, so that the cover measurements will be made entirely within the selected habitat type (i.e., the transect band will cover the first or last 10 feet of the habitat type, as appropriate).
4. Record the location for the transect band on the aerial photographs and on the data collection form. Use the following alphanumeric naming convention to label each transect band: water year, 4-letter abbreviation for instream cover, and a consecutive number for each transect band, beginning with 001. For example, the first instream cover transect band for WY 2001 would be labeled 01-ICVR-001.

In the Field

5. Begin monitoring at the downstream end of the stream segment to be monitored.
    a. For the Guadalupe River, begin monitoring in Reach A, continuing through Segment 3C.
    b. For Guadalupe Creek, begin monitoring at Almaden Expressway, continuing to Masson Dam.
6. Take a Secchi tube reading at the start of each monitoring day, following the manufacturer’s instructions. If water clarity appears to change substantially during the day, take additional Secchi tube readings. Record Secchi tube readings to the nearest millimeter on the data collection form.
7. Locate the center of the first transect band on the aerial photograph and proceed to that location. Alternately, a measuring tape may be used to locate the center of the transect band in the field by measuring the distance to the center of the transect from the upstream or downstream edge of the habitat type.
8. Establish a transect band with the measuring tape by inserting a chaining pin in the RWE at the center of the transect band and stretching the measuring tape across the wetted channel and perpendicular to the stream flow. Secure the other end of the measuring tape to a chaining pin anchored to the LWE. The measuring tape will be used to determine the width of instream cover across the transect band.

Note: Right and left banks are relative to a person facing downstream (Armantrout, 1998).

9. Measure 5 feet upstream and downstream from the measuring tape, and mark the ends of the transect band on each bank with pin flags.
10. Identify features within the transect band that qualify as cover (figure 5-3). Instream cover includes undercut banks with an undercut width greater than 4 inches; roots, logs, and debris piles greater than 155 square inches, or 1.1 square feet, in surface area; and boulders and rocks greater than 8 inches in diameter (Jones & Stokes Associates, 1997; Fris and DeHaven, 1993). Also identify submerged and emergent vegetation, such as watercress (*Rorippa nasturtium-acquaticum*), tules (*Scirpus* species), and cattails (*Typha* species), within the transect band. Multiple tree branches and aquatic vegetation with individual stems that are less than 4 inches in diameter may be counted as cover when considered as a whole. The cover designation and extent will be based on professional judgment.

Note: Any cover intercepted by the 10-foot-wide transect band is measured as if intercepted by a line transect (Fris and DeHaven, 1993). For example, in a 20-foot-wide stream, a 4-foot-long piece of wood that is 1 foot in diameter, perpendicular to stream flow, and intercepted by the transect band would be counted as 20% cover (4 feet divided by 20 feet). If the piece of wood was parallel to stream flow, it would be counted as 5% cover (1 foot divided by 20 feet).

11. Measure the distance from the right bank for the starting and ending edge of each cover feature (i.e., undercut banks, instream woody material [e.g., roots, logs, tree branches, and debris piles], boulders and rocks, herbaceous vegetation, or riprap [e.g., concrete, rock, or other hard cover that has clearly been introduced into the stream channel through human activities]). Also indicate the starting and ending edge where cover is absent (i.e., no cover present).
12. Record the measurements and cover type on the upper table on the data collection form.
13. Repeat for all transect bands.

Note: In situations where deep water or water clarity does not permit visual observations of the channel bottom, it will be necessary to walk within the transect band or probe along with a stadia rod from a float tube to determine the presence and extent of instream cover features.

In the Office

14. Transform the instream cover data recorded on the upper table of the data collection form to the format on the lower table of the data collection form. This transformation allows the RDBMS to account for overlapping cover.

a. Starting with the cover closest to the right bank, check the column for the applicable instream cover type. If multiple types of cover overlap (i.e., occur at the same point along the transect band; they do not have to literally overlap), check the columns for all overlapping cover types.

b. Record the first point (start point) at which the cover type (or group of cover types, in the case of overlapping cover) intersects the transect band.

c. Record the last point (end point) at which that same cover type (or group of cover types) intersects the transect band.

d. Each time a change in cover occurs, begin a new line on the lower table. A change in cover includes the start and stop of each cover type. For example, if instream woody material started at 1.5 feet and ended at 5.0 feet and a rock started at 3.5 feet and ended at 6.5 feet, fill out 3 lines of the lower table. On the first line, "instream woody material" would be checked, the start point would be 1.5, and the end point would be 3.5. On the second line, both "instream woody material" and "boulders, rocks" would be checked, the start point would be 3.5, and the end point would be 5.0. On the third line, "boulders, rocks" would be checked, the start point would be 5.0, and the end point would be 6.5.

Note: The table for the transformed data continues onto the back of the data collection form.

5.9.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the instream cover indicator.

5.9.2 Data Management

Instream cover data will be collected once a year between June and October immediately following Project construction and every third year until MY 10 (MYs 0, 3, 6, 9, and 10). Instream cover data are recorded on data collection form SRA-07. This indicator is recorded for 100 randomly selected instream cover transect bands. Instream cover data are stored in the RDBMS of GEMS.

5.9.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the instream cover indicator:

- tblSRAInstreamCover (primary data table),
- tblStream,
- tblStreamSegment,

- tblSICData,
- tblSICDataCover,
- tblCoverType,
- tblSICTeam, and
- tblMembers.

Figure B-12 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.9.2.2 Data Entry

Data from the SRA-07 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.9.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.9.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be entered during data entry:

- stream segment and
- instream cover type.

5.9.3 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with instream cover transects will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized transects will be attributed with an instream cover identification number. All lines from instream cover monitoring for a given year will be included in 1 shapefile, named “SRA_Instream_Cover_mmmyy,” where “mmm” is month (e.g., “aug”), and “yy” is year (e.g., “01”).

5.9.4 Data Analysis and Evaluation

The analysis and evaluation of the instream cover monitoring data assesses whether the measured instream cover meets the measurable objective of greater than 10% cover over the total stream area sampled at MY 10. Beginning in MY 6, regression analysis will be used each year to predict whether instream cover will reach the measurable objective. In addition, analysis and evaluation may be needed to determine recommendations for remedial actions, if the measurable objective is not met by MY 10.

5.9.4.1 Calculations

Calculate the following variables independently for Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek; and all stream segments combined:

- *average percent cover* (i.e., total instream cover),
- *average percent hard cover* (i.e., rocks, boulders, instream woody material, and undercut banks),
- *average percent riprap cover,* and
- *average percent herbaceous cover* (i.e., herbaceous vegetation that does not overlap with hard cover).

The average will include the percentage from all transect bands within a stream segment.

5.9.4.2 Statistical Analysis Methods

Perform regression analysis in MY 6 and every monitoring period thereafter. Using the regression of *percent instream cover* by *monitoring year*, estimate expected percentage of instream cover at MY 10.

Plot the average percentage calculated from the regression equation (*percent instream cover* by *year*) and the measurable objective for each applicable monitoring period. The measurable objective should be displayed as a horizontal line.

5.9.4.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **All instream cover values are between 0 and 100%.** Examine the range of instream cover values and verify that cover values do not exceed 100%. If cover values exceed 100%, check for data collection errors. If necessary, examine the sampling plot in the field and determine whether the instream cover values are correct. Correct data collection form SRA-07 and GEMS, as appropriate.

5.9.4.4 Comparison to Measurable Objective

Compare the *average percent cover for each stream segment* to the measurable objective of 10%. Note progress toward the measurable objective and discuss potential causes of lower or higher cover values. Based on instream cover in MY 10 and variability in cover from MYs 0, 3, 6, and 9, identify recommendations for future monitoring.

5.10 Channel Bottom Stability Indicator

The SRA cover channel bottom stability indicator represents the change in channel bottom elevation at selected cross sections in natural channel areas potentially affected by Project features. The purpose of monitoring this indicator is to determine whether down cutting of the channel bottom or deposition on the channel bottom is occurring as a result of Project features, such as armored channel sections, constructed low-flow channel sections, invert stabilization control structures, and weirs. Down cutting can cause bank instability and lowering of groundwater levels, resulting in mortality of SRA cover vegetation. Down cutting may also cause the loss of instream cover. Deposition of material raises the channel bottom elevation, potentially causing bank erosion and bank overflow, and can affect anadromous fish passage, spawning gravel quality, and rearing habitat diversity. The measurable objective for the channel bottom stability indicator is an average segment channel bottom elevation change (i.e., the average elevation change of the cross sections averaged for each segment) of less than 0.5 foot relative to the first monitoring year (MMP section 4.3.4.9).

5.10.1 Data Collection

5.10.1.1 Permit Requirements

No permits are required for conducting the channel bottom stability monitoring described below.

5.10.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photograph showing the location of the 14 permanent cross sections to be monitored (appendix E),

- 100-foot measuring tape (marked in tenths of a foot),
- chaining pins (2 pins; to secure measuring tape),
- monument locations and elevations (appendix G),
- stadia rod (marked in tenths of a foot),
- rod-level (optional, to ensure stadia rod is held vertically),
- tripod-mounted surveyor's level,
- chest waders and a life jacket (for each team member), and
- data collection form SRA-08 (at least 30 copies of the form; appendix D).

5.10.1.3 Schedule

Channel bottom stability will be monitored once a year between April and October. Channel bottom stability will be monitored prior to Project construction (for the channel bottom stability transects in the Woz Way to Park Avenue Bypass and Segment 3B but not for the channel bottom stability transects in Segment 2 because the Project had been constructed in Segment 2 prior to finalization of the MMP and its requirement for preproject monitoring), immediately following construction (MY 0), and once a year following construction through MY 10.

5.10.1.4 Location and Access

The channel bottom stability indicator will be monitored at cross sections in Segments 2 and 3B and Woz Way to Park Avenue Bypass. Cross sections are numbered from 1 to 14, starting at the downstream end of Segment 2 (appendix E). Access to these areas requires coordination with the SCVWD.

Channel bottom stability may be monitored in Reach A and Guadalupe Creek if mitigation for these areas involves work in the channel bottom that could affect stability. Currently, no channel bottom stability cross sections are proposed for Reach A and Guadalupe Creek.

5.10.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor channel bottom stability. These steps are described in detail later in this chapter.

To monitor channel bottom stability, the monitoring team will

- review the known-elevation points used in previous survey work,
- record the known-elevation points for each cross section,

- conduct cross-section profile monitoring at all cross-section locations, and
- record channel bottom stability data on data collection form SRA-08.

5.10.1.6 Mapping and Documentation

In the Office

1. Review aerial photographs to determine the locations of the cross sections (appendix E). These cross-section locations were identified in the MMP (section 4.3.4.9) and further refined during October 2000 field work.
2. Review previous monitoring data to determine which known-elevation points were used. This step will reduce the time needed in the field and improve consistency.
3. Review appendix G to determine elevations of known points, such as cross-section monuments or other benchmarks.

In the Field

Notes: Where necessary, a specific team member has been identified (in brackets) to conduct certain tasks. The distinction between team members is meant to facilitate coordination in the field. Either team member may conduct any task.

All readings must be accurate to within 0.1 foot.

4. Locate the cross section using the aerial photographs (appendix E).
5. Locate the cross section's monuments using a GPS receiver and/or a metal detector, and record the cross-section number on the data collection form.
6. (Team member 1) Set up and level the tripod and surveyor's level in a location where the entire cross section and a known-elevation point can be seen (figure 5-4).
7. Record the cross-section identification number and elevation of the known-elevation point (from appendix G) on the data collection form.
8. (Team member 2) Set the stadia rod on the known-elevation point and hold the rod perfectly vertical (a rod level may be helpful).
9. (Team member 1) Site the rod through the level and record the rod reading as a backsight reading (a reading taken at a point of known elevation).
10. Add the backsight to the elevation of the known-elevation point to determine the height of the instrument.
11. Record the height of the instrument.
12. Attach the measuring tape to the left bank monument with a chaining pin, and stretch the tape to the right bank monument.

Note: Left and right bank are relative to a person facing downstream.

13. Attach the measuring tape to the left bank monument with a chaining pin, and stretch the tape tight to prevent it from sagging.
14. (Team member 2) Set the rod on the right bank monument and hold the rod perfectly vertical.
15. (Team member 1) Site the rod through the level and record the reading as a foresight (a reading taken on a point whose elevation is to be determined).
16. Moving from left to right, take a foresight reading every 2 feet across the channel or every 5 feet across the floodplain and terraces (figure 5-5). Be sure to place the rod firmly on the channel bottom and hold it perfectly vertical (a rod-level may be helpful).
17. Record the position of the rod on the measuring tape (to the nearest 0.1 foot) as the station (distance from the left bank).
18. Record on the data collection form the station and foresight reading at each 2-foot interval and at significant changes in ground surface slope.

    Note: Record the station and foresight readings to the left of the base of the left bank monument and to the right of the base of the right bank monument on the upper table on the data collection form. Record the station and foresight readings between the base of the left bank monument and the base of the right bank monument (i.e., only the readings that will be used to calculate average channel bottom elevation) on the lower table of the data collection form.

19. Continue across the cross section to the right bank monument.
20. Measure and record the station and foresight reading of the right bank monument.
21. Note the location of important features, such as the top and bottom of the banks, the LWE and RWE, the deepest point in the channel, and the top and base of the monuments. Locations should be recorded relative to the monuments.
22. Close out the survey by reshooting the backsight (i.e., the known-elevation point).
23. Record this last backsight reading as a foresight reading.
24. Compare this last reading to the original backsight reading. The 2 readings should be within 0.1 foot. This step ensures that the surveyor’s level has not moved.
25. Determine and record the elevations of all foresight readings by subtracting the foresight reading from the height of instrument. This step should be done for quality assurance.
26. Repeat steps 4–25 for the remainder of the cross sections.

5.10.1.6.1 Immediate Remedial Actions Required

No immediate remedial actions are required for the channel bottom stability indicator.

5.10.2 Data Management

SRA cover channel bottom stability data will be collected once a year between April and October prior to Project construction (for Segment 3 only because the Project had been constructed in Segments 1 and 2 prior to finalization of the MMP and its requirement for preproject monitoring), immediately following Project construction, and every year thereafter through MY 10 (preproject for Segment 3 and MYs 0–10, respectively). Channel bottom stability data are recorded on data collection form SRA-08. This indicator is recorded for each channel bottom stability cross section. Channel bottom stability data are stored in the RDBMS of GEMS.

The method described in the data collection section assumes that data are collected using a surveyor's level and that data are recorded by hand on the data collection form. Alternatively, digital surveying equipment, such as laser range finders and total station devices, can be used to record the data digitally during monitoring. If a digital device is used, the data entry step is skipped.

5.10.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the channel bottom stability indicator:

- tblSRAChannelBottomStability (primary data table),
- tblCrossSection,
- tblKnownElevation,
- tblSCBMeasure,
- tblSCBMeasure2,
- tblSCBTeam, and
- tblMembers.

Figure B-13 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

5.10.2.2 Data Entry

Data from the SRA-08 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

5.10.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

5.10.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- cross-section identification number and
- known elevation point.

5.10.3 Data Analysis and Evaluation

The analysis and evaluation of the channel bottom stability monitoring data assesses whether the measurable objective of an average segment channel bottom elevation change (i.e., the average elevation change of the cross sections averaged for each segment) of less than 0.5 foot relative to the first monitoring year will be met in MYs 0–10. This assessment should be based on trends observed over 3–5 years, unless observations in one monitoring year indicate a change that is clearly detrimental to meeting the long-term intent of the MMP.

In addition, areas where channel stabilization needs to occur, if any, should be identified.

5.10.3.1 Calculations

Calculate the following variables.

- *Average channel bottom elevation for each cross section.* Sum the elevation of points surveyed between the left and right top of bank and divide by the total number of points.
- *Channel width for each cross section.* Calculate the distance between the left and right top of bank.

- *Change in channel bottom elevation relative to the first monitoring year.* Subtract the *average channel bottom elevation for each cross section* in the current monitoring year from the *average channel bottom elevation for each cross section* for the first monitoring year.
- *Average channel bottom elevation* by *segment*. For each segment, sum the average channel bottom elevations calculated for the cross sections and divide by the number of cross sections in that segment.
- *Change in channel bottom elevation* by *segment relative to the first monitoring year.* Subtract the *average channel bottom elevation by segment* in the current monitoring year from the *average channel bottom elevation by segment* for the first monitoring year.

5.10.3.2 Statistical Analysis Methods

Prepare the following graphs.

- *Measured channel bottom elevations for each cross section*. For each cross section, each monitoring period should be plotted as a different line on the same graph, with distance from the west monument on the x-axis and elevation on the y-axis. Changes in elevation at each point and changes in channel width will be apparent through time.
- C*hange in channel bottom elevation relative to the first monitoring year for all cross sections in each segment.* For each monitoring year, the change in elevation should be plotted as a different line on the same graph, with cross-section location (i.e., distance upstream from the first transect) on the x-axis and elevation on the y-axis.

Compare the *average channel bottom elevation by segment* for the current year to the *average channel bottom elevation by segment* for the previous 3–5 years and to the *average channel bottom elevation by segment* for the first monitoring year.

5.10.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

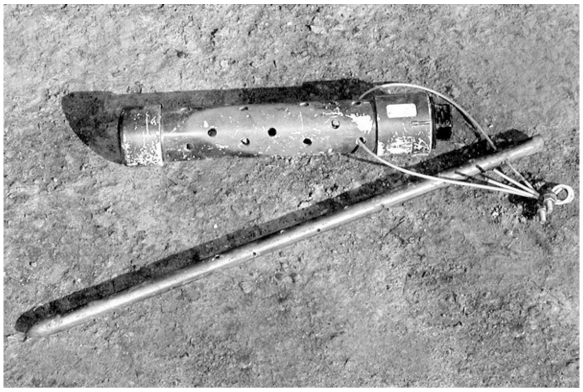
- *Large changes in channel bottom elevation between monitoring years.* Compare average channel bottom elevation and channel bottom elevation at points along the cross section for each cross section. Determine whether unexpected changes occurred that cannot be easily explained. If changes that cannot be explained are found, review the data collection forms, and examine the cross section in the field to determine whether the elevation values are correct. Correct data collection form SRA-08 and GEMS, as appropriate.
- *Large changes in channel width between monitoring years.* Compare channel width for each cross section between monitoring years. Determine whether unexpected changes occurred that cannot be easily explained. If

changes that cannot be explained are found, check the data collection forms, and examine the cross section in the field to determine whether the width value is correct. Correct data collection form SRA-08 and GEMS, as appropriate.

5.10.3.4 Comparison to Measurable Objective

Discuss the potential cause of changes in average segment channel bottom elevations greater than 0.5 foot and potential effects of the current trend in elevation changes relative to MMP objectives (e.g., bank stability, riparian and SRA cover vegetation, and spawning gravel abundance and quality). Discuss the graphs for each cross section, pointing out changes in bottom elevation and channel width from monitoring year to monitoring year. Identify any trends in changes for average channel bottom elevation and average channel bottom elevation by segment that have occurred over the previous 3–5 monitoring years. Based on variability in channel bottom stability from MYs 1 to 10, discuss recommendations for remedial actions and future monitoring.

Chapter 6
Water Temperature



Water temperature logger case

6.1 Introduction

Suitable water temperatures are critical to the survival of steelhead (*Oncorhynchus mykiss*) and Chinook salmon (*O. tshawytscha*). Water temperature is controlled by many factors, including stream flow, meteorology (e.g., air temperature, wind speed, solar radiation, and dew point temperature), stream channel geometry, and shade. The Project does not affect stream flow or meteorology; however, the Project does affect stream channel geometry and shade.

The JSATEMP model will be used to evaluate the effects of the Project on water temperature. Because stream flow and meteorological conditions vary from year to year, Project effects on water temperature cannot be isolated by simply comparing water temperatures before and after Project construction. The JSATEMP model removes the confounding effects of variable stream flow and meteorological conditions, thereby permitting a clear representation of the thermal effects caused by Project changes to stream channel geometry and shade.

6.1.1 Chapter Organization

To best describe the use of the JSATEMP model and its relationship to the water temperature indicators and environmental condition parameters, this chapter is organized differently from the other chapters in the IP. Information is presented in this chapter in the following order:

- "Introduction" provides an overview of this chapter. It also provides important definitions for the reader and information about the water temperature analysis process.

- "Data Collection" describes the data collected for evaluation of the JSATEMP model: measured water temperature, solar heat transfer, stream channel geometry, stream flow, and hourly meteorological data.
- "JSATEMP Model Simulations" describes the basics of how to
    - ☐ compare field measurements of solar heat transfer, stream channel geometry, and stream flow with JSATEMP model calculations,
    - ☐ evaluate JSATEMP model results by comparing simulated to measured water temperatures, and
    - ☐ simulate current-postproject and no-project water temperature conditions.
- "Monthly Thermal Suitability Indicator" describes the indicator and measurable objective defined in the MMP, explains the final data analysis and evaluation steps that need to be performed using the JSATEMP model, and outlines the reporting procedures.
- "Short-Term Thermal Suitability Indicator" describes the indicator and measurable objective defined in the MMP, explains the final data analysis and evaluation steps that need to be performed using the JSATEMP model, and outlines the reporting procedures.
- Appendix H contains detailed information about the JSATEMP model, including specific information on how to
    - ☐ compare the data that has been collected in the field to the values calculated by the model,
    - ☐ enter inputs,
    - ☐ run the model,
    - ☐ evaluate model performance,
    - ☐ adjust the model if necessary,
    - ☐ simulate current-postproject and no-project temperatures, and
    - ☐ obtain indicator values from the model.

6.1.2 Important Definitions

There are 4 important definitions that the reader should keep in mind for this chapter:

- *indicator* versus *environmental condition parameter*,
- *current-postproject* versus *no-project*,
- *segment* versus *model segment*, and
- data type.

6.1.2.1 Indicator Versus Environmental Condition Parameter

The environmental condition parameters for water temperature are

- measured water temperature,
- solar heat transfer,
- stream channel geometry,
- stream flow, and
- hourly meteorological data.

These environmental condition parameters are not used directly in the assessment of water temperature. Instead they are used for evaluating or running the JSATEMP model, which is used to calculate the water temperature indicator values. The indicators for water temperature are

- monthly thermal suitability and
- short-term thermal suitability.

6.1.2.2 Current-Postproject Versus No-Project

As described in greater detail below, the main purpose of the water temperature analysis is to estimate the effect of the Project on water temperatures. This estimate is made by comparing current-postproject temperatures to no-project temperatures. No-project temperatures are estimates of what current water temperature would be if no components of the Project had been constructed. Current-postproject temperatures represent the actual conditions at the time of the water temperature measurements. Initially, current-postproject temperatures will represent the Project in a state of partial completion, with some components constructed and other components pending.

6.1.2.3 *Segment* Versus *model segment*

Two types of segments are discussed in this chapter: Project Segments and model segments. The first type of segment, *Segment*, is shown in upper case and refers to Project Segments 1, 2, 3A, 3B, and 3C. The second type of segment, *model segment*, is shown in lower case (unless punctuation dictates otherwise) and refers to segments used in the JSATEMP model. In the JSATEMP model, the Guadalupe River system is divided into 39 model segments, which are used for model calculations. Eleven of these segments are directly affected by Project construction and mitigation and, therefore, are discussed in this chapter (table 6-1).

Table 6-1. Location of Model Segments Affected by Project Construction and Mitigation

Model Segment Number[a]	General Location	Upstream Boundary	Downstream Boundary
5	Guadalupe Creek	Masson Dam	Meridian Avenue
6	Guadalupe Creek	Meridian Avenue	Guadalupe River
30	Segment 3C	Grant Street	Woz Way
31	Woz Way to Park Avenue Bypass	Woz Way	Park Avenue
32	Segment 3B	Park Avenue	West Santa Clara Street
33	Segment 3B	West Santa Clara Street	Old West Julian Street
34	Segment 3A	Old West Julian Street	Coleman Avenue
35	Segment 2	Coleman Avenue	West Taylor Street
36	Segment 2	West Taylor Street	Hedding Street
37	Segment 1	Hedding Street	Interstate 880
38	Reach A	Interstate 880	Airport Parkway

[a] Model segment boundaries are at the upstream edge of bridges.

6.1.2.4 Data Types

Two data types used in the JSATEMP model can be broadly defined as *field-measured data* and *gage-measured data*. For the purposes of this chapter, *field-measured data* are data collected in the field specifically for use in the Project's monitoring program.

Field-measured data are used in the calculations and quality assurance measures that need to be performed before JSATEMP model simulations can be run, and they are used in the JSATEMP model water temperature simulations. Field-measured data are

- measured water temperature data,
- solar heat transfer data,
- stream channel geometry data, and
- stream flow data (2 types)
  - ☐ stream flow data collected simultaneously with stream channel geometry monitoring and
  - ☐ stream flow data collected monthly.

Gage-measured data are data not collected specifically for the Project's monitoring program. These data are from the SCVWD, USGS, and CIMIS. Gage-measured data are

- stream flow data from USGS and SCVWD stream gages and
- meteorological data from the CIMIS station at Morgan Hill.

Table 6-2 shows how the various data are used in the JSATEMP model.

Table 6-2. Types of Data Used in the Current-Postproject and No-Project Simulations of the JSATEMP Stream Temperature Mode

Value	Data Compared to JSATEMP Model Calculations to Check Model Parameters	Input for Simulation of Current-Postproject Water Temperatures	Input for Simulation of No-Project Water Temperatures
Current-Postproject Data			
Solar heat transfer	x		
Stream channel geometry	x		
Field-measured stream flow	x		
Measured water temperature at inflow locations[a]		x	x
Measured water temperature in the Project area[b]	x		
USGS and SCVWD stream flow		x	x
CIMIS meteorology		x	x
Preproject Data			
Solar heat transfer	x		
Stream channel geometry	x		
Current-Postproject Parameters			
Shade		x	
Stream channel geometry		x	
No-Project Parameters			
Shade			x
Stream channel geometry			x

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[a] Measured water temperature at inflow locations is recorded at 4 locations: Guadalupe Reservoir release, Guadalupe Creek downstream of Masson Dam, upstream end of the Project area (i.e., near Virginia Street on the Guadalupe River), and Los Gatos Creek.

[b] Measured water temperature in the Project area is recorded at 6 locations: upstream of Almaden Expressway on Guadalupe Creek, upstream of the confluence of Los Gatos Creek with the Guadalupe River, downstream of the confluence of Los Gatos Creek with the Guadalupe River, near Coleman Avenue on the Guadalupe River, near Interstate 880 on the Guadalupe River, and near Airport Parkway on the Guadalupe River.

6.1.3 Summary of Water Temperature Analysis Process

The overall procedures described in this chapter and appendix H for data collection and use, JSATEMP model adjustment, water temperature simulation, and water temperature indicator analyses for steelhead and Chinook salmon are summarized as flowcharts in figures 6-1 and 6-2. These figures are a road map for the reader to follow as the complex data sets, model simulations, and indicator analyses are described.

Prior to simulating Project effects on water temperature, collected data are used to evaluate the accuracy of model parameters for shade, stream channel geometry, and local changes in stream flow. Then, as shown in figure 6-2, water temperature is simulated for 2 conditions: current-postproject conditions (postproject conditions during the time data are collected) and no-project conditions (conditions during the time data were collected, assuming the Project had not been constructed.)

The first water temperature simulation models current-postproject water temperature conditions. This simulation uses CIMIS meteorological data and USGS and SCVWD stream flow data for current conditions (table 6-2). Performance of the JSATEMP model is then evaluated by comparing the simulated water temperature data for current-postproject conditions with measured water temperature data. The model may be adjusted, if necessary, and additional model runs conducted until simulated water temperature data are in agreement with measured water temperature data. When these data are in agreement, model performance is satisfactory and the simulation of current-postproject water temperature conditions is complete.

The second water temperature simulation models no-project water temperature conditions. This simulation uses preproject shade parameters, preproject stream channel geometry parameters, current stream flow data, and current CIMIS meteorological data. As a result, the no-project simulation is identical to the current-postproject simulation, except that it uses preproject shade and stream channel geometry data. The 2 water temperature indicators, monthly thermal suitability and short-term thermal suitability, will be used to evaluate the results from the no-project and current-postproject water temperature simulations. Comparison of the indicators will allow Project effects to be evaluated for steelhead and Chinook salmon (figure 6-2).

The main steps in the water temperature analysis process are outlined below.

1. Data are collected in the field.
2. Parameters used in the JSATEMP model are evaluated and adjusted, as necessary, using field-measured and gage-measured data.
3. Water temperatures are simulated using the JSATEMP model.
    a. Current-postproject conditions are simulated.
    b. No-project conditions are simulated.

The monthly thermal and short-term thermal suitability indicators, which quantify Project effects, are generated by the simulations and are compared to their measurable objectives.

6.1.4 Staff Qualifications

To successfully complete data collection, data management, and data analysis and evaluation requirements associated with the water temperature indicators, the following minimum qualifications for staff conducting the work are recommended.

6.1.4.1 Data Collection

Data collection should be performed by staff members with a related 4-year college degree (e.g., biology or hydrology) and 2 years professional experience in aquatic field surveys. Specifically, it is suggested that the staff members have experience with

- performing monitoring in streams;
- use of water temperature monitoring equipment, such as water temperature loggers, pyranometer sensors, and flow meters;
- interpretation of aerial photographs; and
- use of aerial photographs as a field mapping base.

The data collection methods for most environmental condition parameters assume that the work will be conducted by a 2-person monitoring team to facilitate safe and efficient data collection. When 2-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

6.1.4.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 3 years professional experience in database development and administration of Microsoft SQL relational databases.

6.1.4.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in water quality studies. Specifically, it is suggested that the staff members have experience with

- water temperature simulations and
- running computer models.

6.2 Data Collection

Data will be collected for water temperature, solar heat transfer, stream channel geometry, and stream flow. These collected data, together with CIMIS meteorological data and USGS and SCVWD stream flow data, will be used to evaluate JSATEMP model elements, including shade parameters (section 6.2.2), equations for stream channel geometry (section 6.2.3), stream flow calculations for ungaged locations (section 6.2.4), and accuracy of simulated water temperatures (section 6.2.1).

6.2.1 Measured Water Temperature

Water temperature loggers will record hourly water temperature. Measured water temperature is 1 of the 3 types of time-series data required by the JSATEMP model (the other time-series data are the USGS and SCVWD stream flow and CIMIS meteorological data). Measured water temperature will be recorded at 15 locations.

6.2.1.1 Permit Requirements

No permits are required for the measured water temperature monitoring described below.

6.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- computer with software for the water temperature loggers (may be a laptop computer for field use or a desktop computer for office use);
- high-resolution digital camera;
- hand-held water temperature thermometer that can measure temperatures from 0.0 to 37.0 °C in half degree increments (thermometer is for field use and should be protected in a metal case);
- hand-held water temperature thermometer that meets American Society for Testing and Materials (ASTM) specifications for measuring water temperatures from 0.0 to 37.0 °C (thermometer is for office use);
- chest waders and life jackets (for each team member);
- Onset StowAway® water temperature loggers (or comparable water temperature loggers) (at least 15);
- Onset StowAway® water temperature logger shuttle (or comparable equipment) (at least 1);
- submersible water temperature logger cases (cases should be constructed according to the specifications in figure 6-3) (1 for each water temperature logger);
- thin, plastic-coated wire with U-bolts to secure each water temperature logger case;
- orange spray paint;
- wading staff (for stability and identifying deep water); and
- data collection form WATER-01 (1 form for each day of field work; appendix D).

6.2.1.3 Schedule

Measured water temperature will be recorded continuously from April–October prior to Project construction and for 10 years following Project construction (chapter 2). In addition, water temperature data will be measured year-round at 2 locations (Guadalupe River at Grant Street and I-880) to gather information on the suitability of water temperatures for steelhead and Chinook salmon from November–March. At the beginning of each month from May–November, data collected from the water temperature loggers for the previous month will be downloaded for use in the JSATEMP model simulations.

6.2.1.4 Location and Access

The MMP identifies 9 locations for water temperature loggers throughout the Guadalupe River watershed (figure 6-4):

1. downstream of Masson Dam on Guadalupe Creek,
2. upstream of Almaden Expressway on Guadalupe Creek,
3. near Grant Street on the Guadalupe River (0.2 mile upstream of Grant Street at Virginia Street; year-round monitoring location),
4. upstream of the confluence of Los Gatos Creek with the Guadalupe River,
5. on Los Gatos Creek near the confluence with the Guadalupe River,
6. downstream of the confluence of Los Gatos Creek with the Guadalupe River,
7. near Coleman Avenue on the Guadalupe River,
8. near I-880 on the Guadalupe River (year-round monitoring location), and
9. near Airport Parkway on the Guadalupe River.

Six additional locations for water temperature loggers should be monitored beyond those identified in the MMP:

10. at the Guadalupe Reservoir release on Guadalupe Creek,
11. upstream of Masson Dam on upper Guadalupe Creek,
12. at the Almaden Valley Pipeline on upper Guadalupe Creek,
13. at the Alamitos drop structure on the Guadalupe River,
14. at Willow Glen Way on the Guadalupe River, and
15. near Woz Way on the Guadalupe River.

The Guadalupe Reservoir release (#10), Almaden Valley Pipeline (#12), and Willow Glen Way (#14) sites will provide a backup data source for checking the simulated temperatures upstream of lower Guadalupe Creek and upstream of the Project area. These simulated temperatures would be needed if the Masson Dam (#1 and #11) or Grant Street (#3) loggers fail. In addition, information on water temperature in upper Guadalupe Creek could be important for assessing the quality of Guadalupe Creek habitat as a whole. Water temperatures at Willow Glen Way (#14) will provide information on some of the water temperature effects associated with the Upper Guadalupe River Project. The water temperature logger at the Alamitos drop structure (#13) will help confirm that the warm surface water of Almaden Lake dominates the water temperatures at the upstream end of the Guadalupe River.

Eleven of the 15 monitoring locations will be used to assess JSATEMP model performance (i.e., all of the monitoring locations except Guadalupe Reservoir release on Guadalupe Creek [#10], downstream of Masson Dam on Guadalupe Creek [#1], Almaden Valley Pipeline on upper Guadalupe River [#12], and Los

Gatos Creek [#5]). Four of these monitoring locations will be used as model input (i.e., the Guadalupe Reservoir release on Guadalupe Creek [#10], downstream of Masson Dam on Guadalupe Creek [#1], near Grant Street on the Guadalupe River [#3], and on Los Gatos Creek near the confluence with the Guadalupe River [#6]).

Access to the 15 water temperature monitoring locations described above requires coordination with the SCVWD.

Water temperatures measured at locations beyond those described in the IP would benefit the evaluation of JSATEMP model performance. Water temperature data have been measured by the SCVWD at other locations in the Guadalupe River watershed (figure 6-4). Optimally, water temperature data will continue to be collected at these locations. Temperatures immediately downstream of Calero Reservoir on Arroyo Calero and immediately downstream of Almaden Reservoir on Alamitos Creek would be important for simulating temperature in these tributaries.

6.2.1.5 Field Methods

Below is a list that *summarizes* key steps for monitoring water temperature. These steps are described in detail later in this chapter.

To monitor water temperature, the monitoring team will

- check the performance of the water temperature loggers and hand-held field thermometer;
- launch, or activate, water temperature loggers;
- place water temperature loggers at 15 specified monitoring locations and any additional locations on or before March 31;
- record the monitoring location for each water temperature logger;
- photograph the location of the water temperature logger;
- monitor stream flows using data posted on the SCVWD web site;
- check water temperature loggers after high-flow events;
- download water temperature logger data to a shuttle at the beginning of each month;
- record water temperature using a hand-held field thermometer during placement of, data download from, and retrieval of water temperature loggers (for quality assurance);
- retrieve water temperature loggers on or after October 31 to avoid loss during high flows; and
- measure Guadalupe River water temperatures year-round at Grant Street and I-880.

6.2.1.5.1 Mapping and Documentation

6.2.1.5.1.1 Placing the Water Temperature Loggers

In the Office

1. Before the water temperature loggers are deployed, check the accuracy of the loggers and the hand-held field thermometer by comparing their measurements to each other and to the ASTM thermometer readings in crushed ice and at room temperature. If a logger or the hand-held thermometer has more than a 0.5 °C difference from the other loggers or the ASTM thermometer, it should be replaced.
2. Launch, or activate, water temperature loggers following manufacturer's instructions. Water temperature loggers should be programmed to record a temperature every hour. Water temperature loggers can also be launched in the field. On the data collection form, note the time standard used by the logger, Pacific Standard Time (PST) or Daylight Savings Time (DST).
3. Record the 6-digit identification number (i.e., serial number) of each water temperature logger (e.g., 232407) on the data collection form.

In the Field

4. Find suitable positions for the water temperature loggers. A location in the deep point of a stream cross section through riffles, runs, or pool tailouts will ensure that the water temperature logger remains submerged in the stream during the data collection period. Avoid pools greater than 4 feet deep because they may become thermally stratified at low flows and logger recovery may be difficult in these areas at high flows. Also avoid slow-moving edge water, where the water temperature may not represent temperature in the main channel. Loggers should be out of view of the public to minimize vandalism and theft.
5. Place the water temperature logger in a submersible case.
6. Secure the water temperature case to a stationary object, such as a tree or root, with plastic-coated wire and a U-bolt to minimize the chance that the logger will be lost during high flows (figure 6-5).
7. Record the location of the water temperature logger on the data collection form and indicate that it was placed.
8. Take a water temperature reading using a hand-held thermometer and record the reading and the time of the reading on the data collection form.
9. Photograph the location of the water temperature logger, including significant and recognizable landmarks, to aid in the retrieval of data and the logger. Record photograph orientation relative to upstream or downstream or the east or west bank on the data collection form.
10. If relocating the logger may be difficult, spray an orange dot on a nearby landmark for future reference.

In the Office

11. Download the digital images for filing in GEMS.

6.2.1.5.1.2 Checking Water Temperature Loggers after Storms

In the Field

Large storms are unlikely during the April–October monitoring period, but they may occur. Storms are likely to affect the 2 year-round temperature-monitoring sites. Check water temperature loggers after high flows, following the steps below.

1. Monitor stream flows during and after storms. Stream flow data maintained by the SCVWD can be accessed on the Internet at alert.valleywater.org/gagestrm.html.

   - For the Guadalupe River, use the USGS gage upstream of the Highway 101 bridge (gage number 11169025).
   - For Guadalupe Creek, use the SCVWD gage downstream of the Guadalupe Reservoir (gage number 17).

   Note: The SCVWD web site contains the USGS gage data, but the data on the USGS web site (water.usgs.gov/ca/nwis/current) may be more current. Data obtained directly from personnel at the SCVWD may be more accurate, but for determining whether high-flow events occur, the data from the web sites should be sufficient and may be the only recent data available.

2. Check water temperature loggers in the field if flows have exceeded 500 cfs. Find the water temperature loggers in the field, using the narrative description and/or digital images previously taken of each water temperature monitoring location.

3. If the water temperature logger is no longer submerged, resubmerge and secure it. Record the date and time on the data collection form and indicate that the water temperature logger was not submersed and had to be repositioned.

4. If the water temperature logger is lost, deploy a new logger.

6.2.1.5.1.3 Downloading Water Temperature Data Each Month

In the Field

1. Find the water temperature loggers in the field, using the narrative description and/or digital images previously taken of each water temperature monitoring location.
2. If the water temperature logger is no longer submerged or appears to have been disturbed in any way, it should be replaced and brought back to the office for accuracy testing (section 6.2.1.5.1.1).
3. Take a water temperature reading, using the hand-held thermometer and record the time and reading on the data collection form.
4. Check the water temperature logger identification number against the data collection form.
5. Download the data from the water temperature logger to the shuttle, using the manufacturer's instructions. The shuttle will relaunch the logger. Reposition the logger in the stream channel.
6. Compare the reading from the hand-held thermometer to the water temperature logger readings soon after downloading the logger data, so that the logger can be replaced quickly if a problem is detected. The readings from the hand-held thermometer should not be expected to exactly match the logger reading because the logger reading for the last hour will probably have been taken prior to the measurement with the hand-held thermometer.

In the Office

7. At the end of the season, after the water temperature loggers are retrieved, check the accuracy of the water temperature loggers and the hand-held field thermometer by comparing their measurements to each other and to the ASTM thermometer readings in crushed ice and at room temperature. If a water temperature logger or the hand-held thermometer has more than a 0.5 °C difference from the other loggers or the ASTM thermometer, replace it.

6.2.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the measured water temperature environmental condition parameter.

6.2.1.6 Data Management

Measured water temperature is recorded hourly from April–October at 15 locations and year-round at 2 locations. It will be measured prior to Project construction (preproject monitoring) and for 10 years following Project construction (MYs 1–10). Measured water temperature data are recorded by the water temperature loggers, and logger location, placement, download, and retrieval data are recorded on data collection form WATER-01. This environmental condition parameter is recorded for each logger location. The original files downloaded from the loggers are stored by the SCVWD as electronic files, which are backed up each day. Measured water temperature data are entered and stored in the JSATEMP model spreadsheets (in Lotus 1-2-3). Data collected during logger placement, retrieval, and download are stored in the RDBMS of GEMS.

6.2.1.6.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the measured water temperature environmental condition parameter.

- tblWaterTemp (primary data table),
- tblDataLoggerActivity,
- tblWTTeam, and
- tblMembers.

Figure B-14 in appendix B shows the relationships between the primary data table and the metadata tables for the environmental condition parameter.

6.2.1.6.2 Data Entry

Data from the WATER-01 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

Hourly water temperatures recorded by the loggers will be imported into a JSATEMP model spreadsheet. The spreadsheet will be used to calculate minimum, mean, and maximum daily temperatures (appendix H).

6.2.1.6.3 Quality Assurance

The following quality assurance measures should be completed prior to placing the hourly data in the JSATEMP model spreadsheet:

1. Compare the water temperature logger, hand-held thermometer, and ASTM thermometer readings in crushed ice and at room temperature both before logger deployment and after logger retrieval.

2. Compare the measured hourly logger data to the water temperature measured with a hand-held thermometer during placement, monthly downloading, and retrieval of the loggers.
3. Plot the hourly measured water temperature data and visually examine the plot for anomalies. For example, temperatures outside of the range of 32–100 °F are incorrect. More subtle errors may be indicated by abrupt changes in the water temperature pattern. For instance, a sharp increase in the diurnal temperature range may indicate that the water temperature logger was no longer submerged. Abrupt changes in water temperature may also indicate actual events. For example, a sudden increase in the diurnal temperature range downstream of Almaden Lake could be caused by a reduction in water depth upstream of the Alamitos drop structure related to removal of the flashboards installed at the drop structure.
4. To verify that time was accounted for properly, check that the times recorded in the electronic data files match the launch and retrieval times recorded on the data collection forms.

In addition, data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.2.1.6.3.1 Lookup Value

A lookup value is used for the following data entry field to ensure that only valid values can be input during data entry:

- placement, retrieval, or data download.

6.2.1.7 Data Analysis and Evaluation

As described later in this chapter and in appendix H, the water temperatures inserted in the JSATEMP model spreadsheet will be used for model calibration and temperature simulations for April–October. Although the Project has minimal water temperature effects from November–March, data collected for this period at the 2 year-round monitoring locations will be evaluated graphically in the annual mitigation monitoring report and will be compared to fish tolerance ranges for the life stages of steelhead and Chinook salmon that are most abundant in the river during these months.

6.2.2 Solar Heat Transfer

Solar heat transfer, as defined in the MMP, is the amount of solar radiation reaching the stream surface. It is a function of shaded stream surface and solar radiation. Solar heat transfer is an environmental condition parameter, and its data are used to check the shade parameters in the JSATEMP model. Solar heat transfer measurements will be made within the model segments where Project construction and mitigation plantings occur: model segments 5 and 6 (covering Guadalupe Creek), model segments 30–37 (covering Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass), and model segment 38 (covering Reach A). The focus of the solar heat transfer environmental condition parameter is to assess terrestrial and aquatic vegetative shade.

- *Terrestrial vegetation shade* is the stream surface shaded by vegetation (i.e., primarily trees) growing on stream banks or at the water's edge.
- *Aquatic vegetation shade* is the stream surface covered by rooted vegetation that extends above the water surface (e.g., floating water primrose [*Ludwigia peploides*]); it does not include submerged or floating vegetation that is not rooted in the channel bottom or banks (e.g., duckweed [*Lemna* spp.]).

These 2 types of shade are assessed using 3 methods:

- **shade area**—the use of aerial photographs, field confirmation, and GIS to determine the percentage of shade for each model segment at the date and time the aerial photographs were taken (determined for model segments 5, 6, and 30–38),
- **solar radiation**—the field measurement of shade density that is made by comparing solar radiation measurements in shade and in full sun (collected in model segments 5, 6, and 30–38), and
- **aquatic vegetation growth**—the field measurement of aquatic vegetation growth to determine the change in shade that is provided as this vegetation grows through the season (collected in model segments 5 and 6). This measurement does not apply to terrestrial vegetation shade.

6.2.2.1 Permit Requirements

No permits are required for conducting the solar heat transfer monitoring described below.

6.2.2.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will also need the following specialized equipment, listed according to the component being monitored:

Shade Area

- same set of aerial photographs used to monitor SRA cover shaded stream surface indicator (it is necessary to know the flight date and time that these aerial photographs were taken) and
- permanent color pens to mark on the aerial photographs.

Solar Radiation

- same set of aerial photographs used to monitor SRA cover shaded stream surface indicator, showing locations of randomly selected areas for field measurements;
- Li-Cor model LI-250 light meter with pyranometer sensor, or comparable equipment;
- 4-foot dowel to attach to the pyranometer sensor;
- telescoping rod (to extend the light meter over the water if the river is too deep to wade in);
- 100-foot measuring tape;
- chaining pins (3; to secure ends of measuring tape);
- permanent color pens to mark on the aerial photographs;
- chest waders and life jackets (for each team member);
- float tube, pump, patch kit and fins for deep pools;
- wading staff (for stability and identifying deep water); and
- data collection form WATER-02 (at least 1 copy for each model segment; appendix D).

Aquatic Vegetation Growth

- same set of aerial photographs used to monitor SRA cover shaded stream surface indicator;
- steel rebar (2-foot-long section) and metal cap (2 for each line transect);
- mallet to pound in the steel rebar (April only);
- metal detector to locate the steel rebar monuments that mark the start and end points of the transects for the monitoring year;
- 100-foot measuring tape;
- chaining pins (3; to secure ends of measuring tape);
- permanent color pens to mark on the aerial photographs;
- chest waders and life jackets (for each team member);
- float tube, pump, patch kit, and fins for deep pools;
- wading staff (for stability and identifying deep water); and
- data collection form WATER-03 (at least 1 copy for each of the 3 transects; appendix D).

6.2.2.3 Schedule

Shade area and solar radiation share the same monitoring schedule. Aquatic vegetation growth has a different monitoring schedule.

Shade area and solar radiation will be monitored prior to Project construction, immediately following Project construction (i.e., MY 0), and postproject once a year in May–September for MYs 3, 6, and 9 (chapter 2).

- Prior to Project construction—The estimation of preproject shade conditions is described in *Water Year 2001 Mitigation Monitoring Report for the Guadalupe River Project, Downtown San Jose, California* (Jones & Stokes, 2002).
- Immediately following Project construction—Shade area and solar radiation data will be collected in all model segments where Project construction and mitigation occur (i.e., model segments 5, 6, and 30–38), immediately following completion of Project construction.
- Postproject—Shade area and solar radiation data will be collected in all model segments where Project construction and mitigation occur (model segments 5, 6, and 30–38) at 3-year intervals through MY 9, following the monitoring schedule for the shaded stream surface area indictor for SRA cover vegetation. In most cases, the shade area and solar radiation postproject monitoring schedule corresponds to the aerial photograph acquisition schedule (section 3.4.2.5.2). However, when aerial photographs are not acquired in the same year as monitoring of shade area and solar radiation is scheduled, the most recent available set of aerial photographs can be used to determine shade area in the office and map solar radiation data in the field.

Aquatic vegetation growth will be monitored in model segments 5 and 6 monthly in April–October of each monitoring year until an annual growth pattern is established or until aquatic vegetation is shaded out by riparian vegetation.

6.2.2.4 Location and Access

Shade area data, specifically the location of the water’s edge, is field confirmed in model segments 5 and 6 (i.e., Guadalupe Creek) and 30–38 (i.e., Reach A; Segments 1, 2, 3A, 3B, and 3C; and Woz Way to Park Avenue Bypass) (figures 1-2 and 1-3).

Solar radiation data for terrestrial vegetation will be collected at randomly selected shaded areas in model segments 5, 6, and 30–38. These areas will be selected from shaded areas delineated on aerial photographs.

Aquatic vegetation growth will be collected at 3 line transects in model segments 5 and 6. The location of the transects will be selected in April of each monitoring year.

Access to these areas requires coordination with the SCVWD.

6.2.2.5 Methods

Below is a list that *summarizes* key steps that the monitoring team will perform to measure solar heat transfer. These steps are described in detail later in this chapter.

To monitor shade area and solar radiation, the monitoring team will

- use the aerial photographs from SRA cover shaded stream surface indicator monitoring to randomly locate 10 areas shaded by terrestrial vegetation in model segments 5, 6, and 30–38 (in the office);
- measure solar radiation in the full sun and in the first 5 selected shaded areas (the remaining 5 shaded areas are backup sites in case any of the first 5 are unusable [e.g., are sunny or shaded by a structure]);
- record solar radiation data on data collection form WATER-02;
- use field observation to map in the water's edge that is obscured by vegetation on the aerial photographs;
- digitize the shape of the river channel and the shaded areas from aerial photographs taken for the SRA cover shaded stream surface area indictor (the digitized information will be used to determine the percentage of shaded stream surface at the time of the photograph for each model segment where construction and mitigation will occur [table 6-1]); and
- for the same day as field measurements, download hourly solar radiation recorded at the CIMIS station at Morgan Hill to verify the full-sun solar radiation measurements. If meteorological data from a location closer to the Project area become available, data from that location should be used.

To monitor aquatic vegetation growth, the monitoring team will

- use the aerial photographs from SRA cover shaded stream surface indicator monitoring that cover Guadalupe Creek to locate 3 line transects across stream segments supporting a maximum amount of aquatic vegetation (in the office),
- measure aquatic vegetation growth along 3 line transects, and
- record the data on data collection form WATER-03.

6.2.2.5.1 Mapping and Documentation

6.2.2.5.1.1 Shade Area

In the Office

1. Mark the water's edge and the shaded areas within the channel for model segments 5, 6, and 30–38. Map each type of shade with a different color pen. Shade may be associated with

   - terrestrial vegetation (i.e., vegetation growing on the stream banks or at the water's edge),
   - aquatic vegetation (i.e., rooted vegetation growing in the low-flow channel that extends above the water surface),
   - topography, or
   - buildings.

   Bridge shade will not be marked because it has already been estimated using bridge width. In locations of high tree density, the water's edge may be unclear on the aerial photographs and may require field confirmation.

In the Field

2. If the location of the water's edge is unclear on the aerial photographs, whether in the sun or shade, delineate the water' edge on the aerial photographs. This field work will be performed simultaneously with the field work for solar radiation (section 6.2.2.5.1.2).

In the Office

3. Digitize the water's edge and the shaded areas within the channel, using the aerial photographs that have field confirmation of the location of the water's edge. This data will be imported into the GIS database of GEMS.

6.2.2.5.1.2 Solar Radiation

In the Office

1. In model segments 5, 6, and 30–38, mark all terrestrial vegetation shade areas that cover more than 20 feet of stream length, using the aerial photographs (printed at a scale of 1 inch = 50 feet) from the SRA cover shaded stream surface area indictor monitoring. These patches may or may not extend all the way across the river.

2. Beginning at the most downstream area, assign consecutive numbers to each shaded stream area. Areas that cover more than 100 feet of channel length should be broken into equal length segments that are no longer than 100 feet.
3. Use a random number generator, such as Excel's random number generation tool, to randomly select 10 shaded areas for each model segment. The first set of 5 are for field measurements, and the second set of 5 are for backup purposes, if any of the first 5 cannot be used.
4. Using the aerial photographs, identify all stream areas within the Project area that are shaded by aquatic vegetation, topography, or buildings. These areas will be used to check topographic shade density, as described in step 9.

In the Field

Note: One purpose of the field monitoring is to estimate the shade density, which is the effectiveness of terrestrial vegetation at blocking sunlight. Shade density is solar radiation measured in shaded areas divided by solar radiation measured in full sun. For these measurements to be accurate, this monitoring should be conducted on sunny days when solar radiation is not changing rapidly as a result of clouds, a marine layer, fog, or smoke.

5. Select a shaded bank length within each of the 5 preselected shaded areas for each model segment. The length should start at the upstream edge of the shaded area, if possible, and extend for 20–100 feet. The upstream edge is chosen so that the monitor will not inadvertently tend to make the measurement in any particular type of shade (e.g., dense or sparse) within the shaded area. A length of 100 feet is preferable. The length should be clear enough to walk and should not extend out of the shade. Length can be checked with the measuring tape.
6. If the preselected shaded area is sunny or is shaded by the bank or a structure at the time of field measurement, note this information on the data collection form and wait until terrestrial vegetation shade covers the water before measuring solar radiation. Alternatively, select the next area from the second set of 5 randomly selected areas as a replacement site for the segment.
7. Record solar radiation while walking the selected length at a slow, even pace (see note below). Solar radiation is measured using the light meter with attached pyranometer sensor. The light meter should be operated according to manufacturer's instructions. The light sensor should be set to integrate all readings to determine average solar radiation for each 15-second increment. The measurement should be recorded in watts per meter^2. All 15-second integrated solar radiation measurements (15-second readings) should be recorded for the entire length walked.

Note: To measure the shade over the water, walk in the channel if possible. If it is not easy to walk in the channel, the pyranometer light sensor should be extended out over the water with the telescoping rod. The purpose of these measurements is to measure the light passing through terrestrial vegetation, so avoid areas of full sun within the shade patch that are more than 5 feet long. Dappled shade should be considered to be part of the shade patch.

8. Measure the full-sun solar radiation in the vicinity of each selected length. This full-sun measurement will be compared to the collected solar radiation values to determine the shade density. The full-sun measurement will also be compared to solar radiation data recorded by the CIMIS station.
9. If aquatic vegetation, topography, or buildings are contributing to shade, check their shade density by repeating steps 7–8 for a few of these shade areas. Assign these areas identification numbers.
10. Record the following data on the data collection form:
    - date,
    - monitoring team names,
    - shaded stream area identification number,
    - shade type,
    - approximate length walked,
    - model segment,
    - integrated solar radiation measurement(s) for each shaded length,
    - full-sun solar radiation measurement taken near each shaded length,
    - time the solar radiation measurements were taken, and
    - general comments on the terrestrial vegetation providing the shade, such as estimated tree height and canopy diameter, dominant tree species or type(s), and distance of tree trunks from channel. This information could be useful if shade parameters in the JSATEMP model (appendix H) need to be adjusted.

In the Office

11. Download the hourly solar radiation values from the CIMIS station at Morgan Hill (or from a closer location if one becomes available in the future) for each day that solar radiation data are collected. The Morgan Hill data are available at http://wwwcimis.water.ca.gov/cimis/welcome.jsp. Select the following options in the order listed:
    - data reports,
    - hourly report by sensor,
    - Morgan Hill #132,

- sensor #1 – solar radiation,
- units in metric (watts per meter^2),
- dates, and
- reporting method – csv (comma separated values for importing into spreadsheets).

Note: CIMIS requires that you be a registered user to download data from its web site.

6.2.2.5.1.3 Aquatic Vegetation Growth

In the Office

1. Select locations for 3 aquatic vegetation line transects in model segments 5 and 6. The line transects should be located across stream segments that support a maximum amount of aquatic vegetation and should be spaced as evenly apart as possible. However, if aquatic vegetation is confined to 1 portion of model segments 5 and 6, even spacing may not be possible.

In the Field

2. **April only**—Mark the start and end points of each line transect with a rebar monument, and record the location on the aerial photograph and data collection form WATER-03. Use the following alpha-numeric naming convention to label each aquatic vegetation line transect: water year, 4-letter abbreviation for aquatic vegetation line transect, and a consecutive number for each aquatic vegetation line transect, beginning with 001. For example, the first aquatic vegetation line transect for WY 2001 would be labeled 01-AVLT-001.

   May–October—Locate an aquatic vegetation line transect using the description provided on data collection form WATER-03. If necessary, use a metal detector to locate the steel rebar monuments that mark the line transect start and end points.
3. Stretch the measuring tape taut along the ground between the line transect start and end points and secure ends with chaining pins. The tape should be perpendicular to the banks, and the 0-foot mark should be placed at the LWE.
4. Starting at the 0-foot mark, record on the data collection form the start and stop points of aquatic vegetation shade that intersects the line transect. Do not include floating vegetation or vegetation that does not reach the water surface. Record measurements to the nearest 0.1 foot.
5. Continue to walk along the line transect and each time aquatic vegetation starts, begin a new line on the data collection form.

6. On each line of the data collection form, record the type of vegetation and the stream flow at that location relative to the flow at the center of channel (e.g., same, slow, much slower). Also record a visual estimate of the percentage of sunlight that is blocked from reaching the water along the line transect by the aquatic vegetation.
7. Continue along the line transect, recording the data listed in step 6, until the entire line transect has been monitored.
8. **October only**—Remove the rebar monuments that mark the line transect start and end points.

6.2.2.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the solar heat transfer environmental condition parameter.

6.2.2.6 Data Management

Shade area and solar radiation data will be collected once a year in May–September prior to Project construction (preproject monitoring), immediately following Project construction (MY 0) and every third year thereafter through MY 9 (MYs 3, 6, and 9). Shade area data are recorded for model segments 5, 6, and 30–38 and are stored in the GIS database of GEMS. Solar radiation data are recorded on data collection form WATER-02. Solar radiation data are recorded for each of 5 shaded areas in model segments 5, 6, and 30–38 and stored in the RDBMS of GEMS.

Aquatic vegetation growth data will be collected monthly in April–October for each monitoring year until an annual pattern is established or until aquatic vegetation is shaded out by riparian vegetation. Aquatic vegetation growth data are recorded on data collection form WATER-03. The aquatic vegetation growth data are recorded for 3 line transects in model segments 5 and 6 and stored in the RDBMS of GEMS.

6.2.2.6.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to solar radiation:

- tblHeatTransfer (primary data table),
- tblJSATempModel,
- tblHTLightReading,
- tblHTTeam, and
- tblMembers.

Figure B-15a in appendix B shows the relationships between the primary data table and the metadata tables for solar radiation.

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to aquatic vegetation growth:

- tblEmergentVegetation (primary data table),
- tblJSATempModel,
- tblEVData,
- tblEVTeam, and
- tblMembers.

Figure B-15b in appendix B shows the relationships between the primary data table and the metadata tables for aquatic vegetation growth.

6.2.2.6.2 Data Entry

Data from data collection forms WATER-02 and 03 will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

6.2.2.6.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.2.2.6.3.1 Lookup Value

A lookup value is used for the following data entry field for data collected using both the WATER-02 and WATER-03 data collection forms to ensure that only valid values can be input during data entry:

- model segment.

6.2.2.6.4 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with water's edge polygons and in the office with shade areas within the channel polygons will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. All polygons for a given year will be included in 2 shapefiles named "Water_Temperature_<boundary type >_mmmyy," where "boundary type" is river edge boundary or shaded area boundary, "mmm" is month (e.g., "jan"), and "yy" is year (e.g., "01").

Using GIS query capabilities, the GIS analyst will calculate the area of the wetted channel and shade areas within the channel for model segments 5, 6, and 30–38.

6.2.2.7 Data Analysis and Evaluation

6.2.2.7.1 Calculations

Shade terms used in the analysis of solar heat transfer measurements and the JSATEMP model are described in table 6-3.

Two types of shade values must be estimated from the collected data for each model segment: shade density and the shade coverage from terrestrial vegetation, aquatic vegetation, topography, and buildings. These values are used to calculate the shade fractions.

Shade Density. Shade density is the fraction of solar radiation that is blocked by terrestrial vegetation or aquatic vegetation in areas shaded by vegetation. The RDBMS uses the following steps to calculate the average shade density for each model segment.

1. Divide each 15-second reading by its corresponding full-sun reading.
2. Calculate the shade density for each area that was monitored: average all the values calculated in step 1 for each area (15-second readings divided by the full-sun readings).
3. Calculate the shade density for each model segment: average all the values calculated in step 1 for each model segment (15-second readings divided by the full-sun readings). Using this averaging technique ensures that longer shade areas are weighted more heavily than shorter shade areas because the longer shade areas require more 15-second readings.

Shade Coverage. Using the GIS, calculate the proportion of the channel that is shaded by terrestrial or aquatic vegetation, buildings, and topography for each model segment by dividing the shaded stream areas by the total stream areas.

Measured Shade Fractions. Four measured shade fractions are calculated: terrestrial vegetation, aquatic vegetation, building, and topographic shade. The measured terrestrial or aquatic vegetation shade fraction is the shade density multiplied by the terrestrial or aquatic vegetation shade coverage. These vegetation shade fractions are the fraction of solar radiation blocked from reaching the water by terrestrial and aquatic vegetation, respectively, in each model segment at the time that the aerial photographs were taken.

Measured shade fractions for building and topographic shade should be calculated. The aerial photographs will be unlikely to show topographic shade because they are taken at midday. Building shade is also expected to be small because buildings are relatively far from the channel.

Table 6-3. Description of Shade Terms Used in the JSATEMP Stream Temperature Model

Term	Definition	Comments
Terms Associated with Field Measurements		
Shade density measurement	1 minus *solar radiation measured in a shaded* area divided by s*olar radiation measured in full sun (i.e., fraction of solar radiation that is blocked)*	Used only as an intermediary step to calculating *shade density*
Shade density	Average of *shade density measurements*	
Shaded stream area	Stream area shaded by terrestrial vegetation, aquatic vegetation, buildings, or topography in each model segment	Calculated using the GIS.
Shade coverage	*Shaded stream area* divided by *total segment area*	
Measured shade fraction	*Shade density* multiplied by *shade coverage*	Fraction of solar radiation blocked from reaching the water by terrestrial vegetation, aquatic vegetation, buildings, or topography in each model segment at the time that the aerial photographs were taken
Terms Associated with the JSATEMP Stream Temperature Model		
Modeled terrestrial vegetation shade fraction	Terrestrial vegetation shade fraction as calculated by the JSATEMP model	*Modeled terrestrial vegetation shade fraction* is compared directly with the *measured terrestrial vegetation shade fraction*.
Modeled aquatic vegetation shade fraction	Aquatic vegetation shade fraction used by the JSATEMP model	The *modeled aquatic vegetation shade fraction* is set equal to the *measured aquatic vegetation shade fraction*.
Linear vegetation fraction	Fraction of the model segment that is lined with trees.	
Shade factor parameter	*Linear vegetation fraction* multiplied by *shade density* (applies to terrestrial vegetation but not aquatic vegetation)	Two values for each model segment, 1 for each side of the river. *Shade factor parameter* is the maximum possible value for the *modeled terrestrial vegetation shade fraction*
Bridge shade fraction	*Stream area shaded by bridges* divided by *total segment area.*	Calculated using bridge width.
Modeled topographic shade fraction	Topographic shade fraction as calculated by the JSATEMP model.	Calculated using topographic angle.

The measured shade fractions for terrestrial vegetation will be compared to JSATEMP model predictions of these values that correspond to the date and hour when the aerial photographs were taken (appendix H).

Aquatic Vegetation Shade. For each line transect, calculate the percent aquatic vegetation shade per monitoring date. For all 3 line transects, calculate the average percent aquatic vegetation shade per monitoring date.

Prepare the following graphs:

- *percent aquatic vegetation shade* versus *monitoring date* by *line transect* and
- *average percent aquatic vegetation shade* versus *monitoring date for all years*.

The pattern of aquatic vegetation growth determined from the line transects will be used to adjust the measured shade fractions for aquatic vegetation through the growing season. For example, suppose the aerial photographs were taken in September and that the average percentage of the channel covered by aquatic vegetation shade is at a maximum value at that time. If the average percentage of the channel covered by aquatic vegetation in June were half of that in September, the aquatic vegetation shade fraction in June would be half of the value measured from the aerial photographs in September. The monthly values for aquatic vegetation shade fractions are entered directly into the JSATEMP model by being added to the bridge fractions.

6.2.2.7.2 Quality Assurance

To check the light sensor readings, graphically compare the collected full-sun solar radiation measurements to the solar radiation measurements at the CIMIS station recorded at the same time. These values may differ because the 2 sensors do not measure identical wavelengths and because the CIMIS values represent average conditions for the hour previous to the recorded time. However, the 2 sets of readings should be similar, and they should both follow the same daily pattern.

To make a graphical comparison, the CIMIS solar radiation data should be represented on the x-axis and the measured values on the y-axis. The points representing CIMIS and measured value coordinates should indicate a clear linear or curvilinear relationship. If the CIMIS and collected values vary considerably and a relationship between values is not apparent, the accuracy of the CIMIS and collected values should be investigated to determine whether there are problems with monitoring equipment, measurement methods, or data reporting.

For channel areas that coincide with shaded stream surface sampling locations (chapter 5), compare the fraction of stream surface shaded by terrestrial vegetation to the fraction of stream surface that has SRA cover. The relationship should indicate a relatively high degree of correlation for SRA cover and the terrestrial vegetation shade because the aerial photographs used for both values were taken near midday. The terrestrial vegetation shade is expected to cover a slightly larger stream surface than the SRA cover.

Note: SRA overhead cover is vegetation that hangs directly over the stream channel; therefore, SRA cover values do not include all vegetation that may shade the channel when the sun is low in the sky. However, most of the terrestrial vegetation shade evaluated close to solar noon comes from SRA overhead cover.

Total length of aquatic vegetation cannot exceed the width of the wetted channel (i.e., LWE to RWE).

6.2.3 Stream Channel Geometry

Collecting stream channel geometry data shows the depth and width of the stream at regular geographic intervals. Stream channel geometry data are used to determine an average width and average depth value for each model segment in the Project area for use in the JSATEMP model. Stream channel geometry is an important component of the JSATEMP model because the depth and width of the stream directly influence water temperature. It is most important to have data for stream channel geometry during low flows because stream temperature is more sensitive to the influence of shade at low flows, and the diurnal temperature fluctuations are greater because the stream is shallower at low flows. In addition, high flows generally occur during cooler parts of the year when Project effects on water temperature are small.

6.2.3.1 Permit Requirements

No permits are required for conducting the stream channel geometry monitoring described below.

6.2.3.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (to record location of field observations);
- 100-foot measuring tape to measure 100-foot segments of stream length and to measure channel width;
- chaining pins (2; to secure ends of measuring tape);

- depth rod (at least 4 feet long with divisions to 0.1 foot);
- chest waders and life jackets (for each team member);
- float tube, pump, patch kit, and fins for deep pools;
- wading staff (for stability and identifying deep water); and
- data collection form WATER-04 (at least 1 copy for each 1,200 feet of stream to be monitored; appendix D).

6.2.3.3 Schedule

Stream channel geometry data will be collected in all model segments where Project construction and mitigation will occur (i.e., model segments 5, 6, and 30–38) once a year in June–September for preproject conditions, postproject conditions (immediately following Project construction), immediately following Project construction, and at 5-year intervals through MY 10 (MYs 5 and 10). Monitoring should occur during normal summer flow conditions. For Guadalupe Creek geometry measurements, flows should be less than 10 cfs at the gage downstream of Guadalupe Reservoir (SCVWD gage number 17). For Guadalupe River geometry measurements, flows should be less than 10 cfs at the gage upstream of Canoas Creek on the Guadalupe River (SCVWD gage number 23B) and at the gage at the downstream end of Los Gatos Creek (SCVWD gage number 50). All stream channel geometry measurements in a model segment should be completed within a single day, so that the measurements within a model segment are collected at a relatively constant flow.

Stream channel geometry data have been collected for preproject conditions in Reach A and Segments 3A, 3B, and 3C. Preproject stream channel geometry conditions in Segments 1 and 2, which have already been constructed, have been assumed to be the same as the measured postproject channel geometry conditions, except for a small increase in pool depth to account for hardscaping that was added later. Preproject dimensions for the Woz Way to Park Avenue Bypass are the same as those measured in WY 2001. Preproject dimensions for Guadalupe Creek are the same as those used for simulating preproject conditions for the GRR/EIR/SEIS (U.S. Army Corps of Engineers, 2001b).

6.2.3.4 Location and Access

Stream channel geometry data will be collected at cross sections located along every 100 feet of stream length in model segments 5 and 6 (i.e., Guadalupe Creek) and 30–38 (i.e., Reach A; Segments 1, 2, 3A, 3B, and 3C; and Woz Way to Park Avenue Bypass) (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

6.2.3.5 Field Methods

Below is a list that *summarizes* key steps that the monitoring team will perform to monitor stream channel geometry. These steps are described in detail later in this chapter.

To monitor stream channel geometry, the monitoring team will

- download stream flow data from SCVWD gages,
- record the wetted channel width at cross sections located along every 100 feet of stream length,
- record stream depth at 2-foot intervals across the width of each cross section (if the stream channel is less than 10 feet wide, 1-foot intervals should be used), and
- record all stream channel geometry data on data collection form WATER-04.

6.2.3.5.1 Mapping and Documentation

In the Office

1. Obtain SCVWD stream flow data to determine whether flows are appropriate for measuring stream width and depth. Stream channel geometry should be measured at low flows. Stream flow data maintained by the SCVWD can be accessed on the Internet at alert.valleywater.org/gagestrm.html.
    - For Guadalupe River, use the SCVWD gage upstream of Canoas Creek on the Guadalupe River (gage number 23B) and the SCVWD gage at the downstream end of Los Gatos Creek (gage number 50).
    - For Guadalupe Creek, use the SCVWD gage downstream of the Guadalupe Reservoir (gage number 17).
    - Stream flows should be less than 10 cfs at these gages. Stream gage data obtained directly from SCVWD staff are more reliable but may be unavailable. SCVWD staff may be contacted (at 408/265-2607) to determine whether data are available. The current contact is Scott Siegel (extension 2428).

In the Field

Note: Monitoring will be performed at increments of 100 feet from fixed landmarks. This method, combined with mapping of cross-section location, will enable subsequent measurements to be taken at approximately the same locations. Table 6-4 lists the landmarks to use.

Table 6-4. Landmarks for Determining Location of Cross Sections for Stream Channel Geometry Measurements

Starting Landmark	Direction for Progression of Measurements	Ending Landmark	Model Segment
Guadalupe River			
Upstream edge of Airport Parkway	Upstream	Upstream edge of Skyport Drive	38
Upstream edge of Skyport Drive	Upstream	Upstream edge of power lines, just upstream of outfall	38
Upstream edge of power lines	Upstream	Intersection with cross sections starting at Interstate 880	38
Upstream edge of Interstate 880	Upstream	Upstream edge of Hedding Street	37
Upstream edge of Hedding Street	Upstream	Upstream edge of Taylor Street	36
Upstream edge of Taylor Street	Upstream	Upstream edge of Coleman Avenue	35
Upstream edge of Coleman Avenue	Upstream	Upstream edge of New Julian Street	34 and 33
Upstream edge of New Julian Street	Upstream	Upstream edge of West Santa Clara Street	33
Upstream edge of West Santa Clara Street	Upstream	Upstream edge of Park Avenue	32
Upstream edge of Park Avenue	Upstream	Upstream edge of Woz Way	31
Upstream edge of Woz Way	Upstream	Upstream edge of Interstate 280 ramps	30
Guadalupe Creek			
Upstream edge of Almaden Expressway	Downstream	Confluence of Guadalupe Creek with Guadalupe River	6
Upstream edge of Almaden Expressway	Upstream	Intersection with cross sections starting at Meridian Avenue	6
Upstream edge of Meridian Avenue	Upstream	Intersection with cross sections starting at Masson Dam	5

2. Measure stream channel geometry along every 100 feet of stream length.
    a. Starting at the landmarks listed in table 6-4, measure a 100-foot-long segment of stream length by stretching the measuring tape taut and parallel to the stream channel.
    b. Use a chaining pin to hold the start of the tape in place (figure 6-6).
    c. Place the second chaining pin at 100 feet. It will be used as the beginning of the next 100-foot segment and the beginning of the next cross section.
    d. Reset the 100-foot segments at each landmark. For instance, if the end of the last 100-foot segment is 12 feet downstream of the next landmark, begin the next 100-foot segment at the landmark rather than at the end of the last 100-foot segment.

   e. Record whether the measurement is made on the right bank, left bank, or middle of the stream, so that future monitoring will follow the same procedure.

3. Use the following alphanumeric naming convention to label each cross section on the data collection form: water year, 4-letter abbreviation for geometry, and a consecutive number for each cross section, beginning with 001. For example, the first cross section for WY 2001 would be labeled 01-GEOM-001.
4. Mark the location and write the label of the cross section on the aerial photograph.
5. Secure the measuring tape taut across the channel, using the chaining pins. The tape should be perpendicular to the banks and 0 should be placed at the LWE.
6. Measure the wetted channel width of the cross section. The wetted channel width is the width of the channel from water's edge to water's edge, excluding the width of any islands.

   Note: If more than approximately 5% of the wetted channel width contains stagnant water, note the approximate proportion of the wetted channel width that contains stagnant water in "Comments."

7. Measure the stream depth along the cross section at 2-foot intervals, using the depth rod. If the stream is less than 10 feet wide, take depth measurements at 1-foot intervals.

   Note: The first depth measurement can be taken 2 feet from the water's edge if the water is shallow at the edge. If there is a vertical drop at the water's edge of more than 6 inches, take the first depth measurement at the edge.

8. Record the depth (in feet) to the nearest 0.1 foot.

   Note: If an island is present, it should be excluded from the measurement. For example, if the island is located between 10 and 20 feet, the depth reading at 22 feet should be recorded as occurring at a width of 12 feet. Islands are excluded to facilitate data analysis.

9. Record all stream channel geometry data on the data collection form.
10. Move to the next segment.
11. Repeat steps 2–10 until the stream channel geometry at all cross sections has been measured.

6.2.3.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for stream channel geometry environmental condition parameter.

6.2.3.6 Data Management

Stream channel geometry data will be collected once a year in June–September prior to Project construction (preproject monitoring), immediately following Project construction (MY 0), and every fifth year thereafter through MY 10 (MYs 5 and 10). Stream channel geometry data are recorded on data collection form WATER-04. Stream channel geometry data is recorded for each stream channel geometry cross section. Stream channel geometry data are stored in the RDBMS of GEMS.

6.2.3.6.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to stream channel geometry:

- tblStreamChannelGeometry (primary data table),
- tblStream,
- tblStartPoint,
- tblEndPoint,
- tblStreamGage,
- tblJSATempModel,
- tblSCGData,
- tblSCGMeasure,
- tblSCGTeam, and
- tblMembers.

Figure B-16 in appendix B shows the relationships between the primary data table and the metadata tables for stream channel geometry.

6.2.3.6.2 Data Entry

Data from the WATER-04 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS. After the area, width, and average depth for each cross section have been calculated using Excel (section 6.2.3.7), these values are entered into the cross section's data entry form in the RDBMS.

6.2.3.6.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.2.3.6.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream,
- stream gage,
- model segment, and
- location of 100-foot measurement.

6.2.3.6.4 Data Structure and Entry for Aerial Photographs

Aerial photographs annotated in the field with stream channel geometry cross section lines will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized lines will be attributed with cross-section identification numbers. All cross sections for a given year will be included in 1 shapefile named “Water_Temperature_ Stream_Channel_Geometry_ mmmyy,” where “mmm” is month (e.g., “jan”) and “yy” is year (e.g., “01”).

6.2.3.7 Data Analysis and Evaluation

The calculations below are used to determine an average width and average depth value for each model segment in the Project area. The first step is to calculate the area of each cross section.

The area of each cross section is based on sectors, which represent the area between the 2-foot intervals across the stream where depth was measured. The depth measurements (verticals) or the edges of the channel border each sector. Most of the sector areas are trapezoids. However, the area of the first sector, defined by verticals 1 and 2, may be a triangle because the depth of vertical 1 (D_1) may be 0 (figure 6-7). Similarly, the last sector area may also be a triangle. The area of each sector, including the triangles, is the sector width (usually 2 feet) multiplied by the sum of the depths of each edge of the sector divided by 2.

$$\textit{Sector area} = (\textit{sector width})(D_i + D_{i+1}) / 2$$

Where

- $D =$ depth measurement and
- i and i+1 identify the trapezoid sides.

The *cross-sectional area* is the sum of all the sector areas.

Cross-sectional area = $\sum_{i=1}^{n-1} (Sector\ Width\ *\ (D_i + D_{i+1}) / 2)$

Where

- n = the total number of depth measurements, including the 2 edges of the channel and
- i and i+1 identify the trapezoid sides.

The *average model segment width* and *average model segment depth* are calculated for the entire model segment as follows.

$$Average\ width = \frac{\sum widths}{number\ of\ cross\ sections\ within\ the\ model\ segment}$$

$$Average\ depth = \frac{\sum cross-sectional\ areas}{\sum widths}$$

Where

- the sums of the *widths* and *cross-sectional areas* are for all cross sections within the model segment.

Table 6-1 shows the boundaries of each model segment.

6.2.3.8 Quality Assurance

Measured widths will be compared to the GIS database widths for the same locations. These widths should be similar but may not match exactly because the flow at the time of the width measurements might not be the same as at the time the aerial photographs for the GIS database were taken.

In addition, the GIS database should be used to calculate average model segment width by determining surface area and dividing by length. These values should be compared to the average segment widths derived from the field measurements. A mismatch between the average of field measurements and the average calculated by GIS database could indicate that the cross sections selected for the field measurements are not representative of the model segment or that the edge of the water drawn on the aerial photographs is inaccurate.

6.2.4 Stream Flow

Four types of stream flow measurements will be used for the JSATEMP model:

- gage measurements from USGS and SCVWD gages,
- data collected every other month at 3 gage locations,
- data collected simultaneously during stream channel geometry monitoring, and
- data collected monthly at 7 locations.

Stream flow measurements from USGS and SCVWD gages will be used for JSATEMP model input. Flow will be field measured every other month at 3 gages to check the match between gage and field measurements. Data collected simultaneously during stream channel geometry monitoring and data collected monthly at 7 locations will be used to check model assumptions about local flow accretions and depletions. To check model assumptions, the gage measurements from the days corresponding to the field measurements will be entered in the model, and the model estimates of flows between the gages will be compared to the field measurements.

In addition, stream flow measurements collected simultaneously during stream channel geometry monitoring will be used in the stream channel geometry assessment. These flows will be entered in the JSATEMP model to determine model estimates of width and depth at those flows.

6.2.4.1 Permit Requirements

No permits are required for the stream flow measurements described below.

6.2.4.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- depth rod (at least 4 feet long with divisions to 0.1 foot, preferably a top-setting wading rod),
- velocity meter that can be attached to the depth rod and that is accurate to 0.1 foot per second (fps),
- 100-foot measuring tape,
- chaining pins (2; to secure ends of measuring tape),
- chest waders and life jackets (for each team member),
- wading staff (for stability and identifying deep water), and

- data collection form WATER-05 (1 form per flow measurement; appendix D).

6.2.4.3 Schedule

Stream flow data will be collected on 2 different schedules. Stream flow data will be collected at the same time as stream channel geometry data (section 6.2.3) (chapter 2). Each day that stream channel geometry data are collected in a particular model segment, stream flow data should also be collected in that model segment. Stream flow data will also be collected monthly during April–October at 7 locations and every other month at 3 additional locations. The monthly flow measurements should all be made on the same day. The monthly flow measurements will occur each year until flow patterns are well established.

6.2.4.4 Location and Access

Simultaneous with the stream channel geometry monitoring, stream flow data will be collected for 13 cross sections representing the model segments within the monitoring area (figure 6-4). Guadalupe Creek is represented by model segments 5 and 6. Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass are represented by model segments 30–37. Reach A is represented by model segment 38.

In addition, for April–October, stream flow data should be collected monthly at the following 7 locations: on Guadalupe Creek at Meridian Avenue (model segment 6) and Almaden Expressway (model segment 5); and on the Guadalupe River near Virginia Street (model segment 29), St. John Street (model segment 33), Coleman Avenue (model segment 34), I-880 (model segment 37), and Airport Parkway (model segment 38).

Measurements should also be made every other month at the following 3 gage locations for comparison purposes: Guadalupe Creek upstream of Masson Dam, the downstream end of Los Gatos Creek, and the USGS gage upstream of the Highway 101 bridge (gage number 11169025) (model segment 39).

Access to these areas requires coordination with the SCVWD.

Stream flow should be measured near the upstream end of each model segment. Stream flow should also be measured at the downstream end of model segments 6 (the downstream end of Guadalupe Creek) and 38 (the downstream end of Reach A).

6.2.4.5 Field Methods

6.2.4.5.1 Mapping and Documentation

In the Field

Stream flow is determined by measuring depths and velocities for a cross section. The procedure for measuring stream flow (after Dingman, 1994) is described below.

1. Select an area of uniform flow, such as a run or a pool tailout, but not a pool or riffle. Ideally, the cross section will not have large rocks, logs, or other obstacles, and the depth rod will not sink into soft substrate. Establish a cross section perpendicular to the stream flow, with the 0 placed at the LWE. The cross section should span the total wetted channel width.
2. Secure the measuring tape across the width of the channel using the chaining pins.
3. Measure stream depth and flow velocity along the cross section at intervals of 1 foot (if the wetted channel width is greater than or equal to 25 feet) or at intervals of 6 inches to 1 foot (if the wetted channel width is less than 25 feet). There should be at least 25–30 intervals per cross section. If the intervals are not evenly spaced, the greater spacing should occur in the slower moving water.

   a. Measure the depth, using a depth rod with attached velocity meter, at each interval of the cross section. Depth measurements should be recorded (in feet) to the nearest 0.1 foot on the data collection form.

   b. If depth is less than or equal to 2.5 feet, measure velocity at 0.6 of the stream depth: multiply the depth in inches by 0.6 and hold the meter that many inches from the stream bottom. Use of a top-setting wading rod will allow placement of the velocity sensor at the correct position without needing to calculate the appropriate depth. Follow the manufacturer’s directions for operating the velocity meter and the top-setting wading rod. Velocity measurements should be recorded to the nearest 0.1 fps on the data collection form.

   c. If depth is greater than 2.5 feet, measure velocity at 0.2 and 0.8 of the stream depth, and record both velocity measurements on the data collection form.

Note: The velocity meter instructions should be read to determine whether alternative locations of the velocity readings are suggested for the particular meter being used.

4. Fill out the rest of the data collection form. Include comments about water observed to be entering (e.g., through an outfall) or leaving (e.g., through a diversion) the river.
5. Repeat steps 1–4 for the rest of the stream flow measurements.

In the Office

6. Retrieve daily stream flows measured at the USGS and SCVWD gages for 11 locations used in the JSATEMP model for the Guadalupe River watershed (table 6-5). Stream flow data may be considered preliminary because the monitoring results are reported soon after completion of the monitoring for the year, but it can take many months for the USGS and SCVWD to finalize the stream flow values.
7. Daily flow data from gage 46 and the Almaden Valley Pipeline should also be obtained. Gage 46 measures the flow into the off-stream Los Capitancillos percolation ponds. This flow may come from either Guadalupe Creek or the pipeline. The pipeline flows go either to the off-stream percolation ponds or into Guadalupe Creek. These data are not used directly by the JSATEMP model but can be used to estimate diversions from Guadalupe Creek to the off-stream percolation ponds and to estimate the importation of water from the pipeline into Guadalupe Creek. To make these estimates, it should be assumed that diversions would not be made on the same day that water was being imported.

   To obtain stream flow data, contact the SCVWD at 408/265-2607. Scott Siegel is the current contact for gage data (extension 2428), and Judy Nam is the current contact for Almaden Valley Pipeline flows (extension 2747).

Table 6-5. Gage Locations for Stream Flow Data Used in the JSATEMP Stream Temperature Model

Creek/Tributary	Location	Gage
Arroyo Calero	Calero Reservoir release site	SCVWD Gage 13
Alamitos Creek	Almaden Reservoir release site	SCVWD Gage 16
Alamitos Creek	Near Graystone Lane	SCVWD Gage 70
Guadalupe Creek	Guadalupe Reservoir release site	SCVWD Gage 17
Guadalupe Creek	Near Shannon Road	SCVWD Gage 43
Guadalupe River	Alamitos drop structure	SCVWD Gage 20
Guadalupe River	Foxworthy Avenue	SCVWD Gage 23B
Guadalupe River	Upstream of Highway 101 bridge	USGS Gage 11169025
Tributary	Ross Creek	SCVWD Gage 51
Tributary	Canoas Creek	SCVWD Gage 73
Tributary	Los Gatos Creek	SCVWD Gage 50

6.2.4.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the stream flow environmental condition parameter.

6.2.4.6 Data Management

Stream flow data will be collected once a month in June–September prior to Project construction (preproject monitoring), immediately following Project construction (MY 0), and every fifth year thereafter through MY 10 (MYs 5 and 10). In addition, stream flow data will be collected once a month in April–October (at 7 monitoring locations), and periodically in April–October (at 3 monitoring locations). Stream flow data are recorded on data collection form WATER-05 and are stored in the RDBMS of GEMS.

6.2.4.6.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to stream flow:

- tblStreamFlowMeasurements (primary data table),
- tblSFMData,
- tblStreamSegment,
- tblJSATempModel,
- tblSFMTeam, and
- tblMembers.

The data in these tables are used to calculate flow for each location. Figure B-17 in appendix B shows the relationships between the primary data table and the metadata tables for stream flow.

6.2.4.6.2 Data Entry

Data from the WATER-05 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS. The SCVWD and the USGS maintain databases for stream flow measurements from their gages, so it is not necessary to store these values in GEMS. After the stream flow at each monitoring location has been calculated in Excel (section 6.2.4.7), enter the flow value into each monitoring location's data entry form in the RDBMS.

6.2.4.6.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.2.4.6.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream segment,
- model segment, and
- location within the model segment (U, D, or G for upstream end, downstream end, or at the gage, respectively).

6.2.4.7 Data Analysis and Evaluation

As part of stream flow monitoring, water velocities are measured. These velocities will be used to calculate stream flow (in cubic feet per second). The cross section is divided into sectors. Formulas for calculating *sector area* are provided above in section 6.2.3.7. Estimated stream flow through each sector is the average sector velocity multiplied by the sector area:

$$\textit{Sector flow}_i = \textit{average sector velocity}\ (\ \textit{sector area}$$

$$\textit{Average sector velocity} = (V_i(\ D_i + V_{i+1}(\ D_{i+1})/(D_i+D_{i+1})$$

Where

- D_i = depth measurement at vertical i
- V_i = measured velocity at vertical i. As noted in the field methods, the velocity for each vertical is estimated as the velocity measured at 0.6 times the depth (if the depth is less than or equal to 2.5 feet) or as the average of velocities measured at 0.2 and 0.8 times the depth (if the depth was greater than 2.5 feet).

The *total stream flow* is the sum of the flows through all sectors of a cross section.

Total stream flow, Q, is calculated as

$$Q = \sum_{i=1}^{N} \textit{sector flow}_i$$

Where

- N = the number of sectors for the cross section.

Additional description of this technique may be found in hydrology texts such as *Physical Hydrology* (Dingman, 1994).

6.2.4.8 Quality Assurance

The SCVWD and USGS provide quality assurance for the stream flows measured at the stream gages. The periodic field measurements of stream flow at the gages should be similar to the gage-measured stream flows. If they differ by more than 15%, the field method should be reassessed or the SCVWD or USGS should be consulted. At some locations, flow changes throughout the day because of variable flows from outfalls. For this reason, field-measured and gage-measured flows may match better if the hourly, not the daily gage-measured data, are used for comparison.

Anomalous flow measurements may be detected by comparing all the flow measurements to each other and to the gage data. Stream flow is expected to vary from location to location, but extreme deviations should be investigated. In some cases, groundwater accretions, outfalls, percolation, or diversions might cause large differences between stream flows measured at different locations.

6.2.5 Hourly Meteorological Data

Hourly meteorological data from CIMIS are used as input for the JSATEMP model and must cover the full period of the April–October temperature simulation.

To retrieve CIMIS data, follow the instructions near the end of section 6.2.2.5.1. Retrieve hourly data for solar radiation (langleys per day), air temperature (°F), dew point temperature (°F), and wind speed (meters per second).

In the past, the JSATEMP model used meteorological data collected at the San Jose CIMIS station (station 69) (located at the San Jose International Airport). Data collection at this station stopped on November 23, 2002. The model is currently being run with data collected at the Morgan Hill CIMIS station (station 132). Morgan Hill is farther from the Project area than San Jose, and the data collected at Morgan Hill are not as representative of Project area conditions as the San Jose data. If hourly meteorological data are measured closer to the Project area in the future, that data should be used instead of the Morgan Hill data.

To make the Morgan Hill data more similar to the meteorological conditions of the Project area, the data should be transformed. The April–October 2002 data for the San Jose and Morgan Hill CIMIS stations were compared to develop procedures for transforming the Morgan Hill data to make it more similar to the San Jose data. Comparisons were made using both hourly data and daily minimum, mean, and maximum data. In addition, the differences in the data sets were evaluated for trends through time. Many transformation techniques were assessed. The more complicated transformation techniques that were evaluated did not provide much more predictive power than simple linear regressions with the hourly data. The following linear regressions are currently being used to transform the Morgan Hill data:

- $SJair = (MHair)(0.7644) + 15.378$,
- $SJdew = (MHdew)(0.9244) + 8.366$, and
- $SJwind = (MHwind)(0.7286) + 0.319$.

Where:

- *SJ* represents San Jose data,
- *MH* represents Morgan Hill data,
- *air* is hourly air temperature (°F),
- *dew* is hourly dew point temperature (°F), and
- *wind* is hourly wind speed (meters per second).

Solar radiation values do not need to be transformed because the solar radiation measured at Morgan Hill was very similar to that measured at San Jose.

6.2.5.1 Quality Assurance

Check the CIMIS meteorological data for errors prior to using the data for water temperature simulations. Graphically examine CIMIS meteorological data for anomalies. Daily solar radiation values (calculated from the hourly values) that are noticeably above the adjacent daily values are probably incorrect, but large drops in solar radiation are expected during cloudy periods. Dew point temperatures are generally at or below the air temperatures; therefore, values above the air temperature are suspect.

6.3 JSATEMP Stream Temperature Model Simulations

6.3.1 Description of JSATEMP Stream Temperature Model

The JSATEMP model is a spreadsheet-based stream temperature model that uses hourly meteorological data (recorded by CIMIS), daily gage-measured stream flow data, stream channel geometry equations, and shade equations to simulate water temperature. In the model, 39 model segments represent the Guadalupe River system. The model segments cover Arroyo Calero, Alamitos Creek, Guadalupe Creek, and the Guadalupe River (figure 6-4). The length of river represented by individual model segments ranges from 0.2 to 1.5 miles. Each spreadsheet contains all the data needed to simulate hourly water temperatures for a 1-month period. The water temperature for the last hour of a month can be used as the initial water temperature for the next month.

The JSATEMP model simulates water temperature for each model segment. The water temperature in each model segment is determined by the temperature of the water flowing into the segment and by heat transfer relationships between the water and its surroundings. The heat transfer equations account for solar radiation, stream shading, long-wave radiation to and from the water surface, evaporation, convection, and bed conduction.

Figure 6-1 shows the process of using field-measured and gage-measured data to evaluate the accuracy of input parameters and model predictions of temperature. Figure 6-2 shows the process of simulating current-postproject and no-project temperatures for the purpose of calculating suitability indices and determining whether remedial actions for steelhead and Chinook salmon are needed. Additional description of the model can be found in appendix H and in *Simulation of Temperature Impacts and Associated Mitigation Measures for the Guadalupe River Project, Downtown San Jose, California* (U.S. Army Corps of Engineers, 2004).

6.3.2 Simulated Water Temperature—Postproject Conditions

The JSATEMP model will be used to simulate water temperatures for April–October. This section includes general information on how to simulate current-postproject conditions, evaluate model performance, and recalibrate the model, if necessary. More specific instructions are included in appendix H.

6.3.2.1 Inputs to the JSATEMP Stream Temperature Model

CIMIS hourly meteorological data and USGS and SCVWD daily stream flow data are 2 important inputs to the JSATEMP model. These data must be provided for each increment of time to be simulated. Two other important model inputs, shade and stream channel geometry parameters, do not vary over the simulated month, although the hourly shade and daily channel geometry values calculated from these parameters will vary with sun position and flow. Measured water temperature data should also be placed in the model spreadsheet. Some of the measured temperatures are used as model input, but most are used for evaluating the accuracy of model results. For more information on the model inputs, see appendix H.

6.3.2.2 Comparing Model Estimates of Solar Heat Transfer, Stream Channel Geometry, and Stream Flow with Field-Measured Data

6.3.2.2.1 Solar Heat Transfer

The measured terrestrial and aquatic vegetation shade fraction collected for each model segment during solar heat transfer monitoring (section 6.2.2) will be compared with the modeled terrestrial and aquatic vegetation shade fraction simulated by the JSATEMP model for the date and time corresponding to the measurement (appendix H). In areas where vegetation is believed to have changed, the new estimates of the shade parameters (appendix H) should be inserted in the model prior to this comparison. If topographic shade was present in the aerial photographs, also compare the measured topographic shade fractions with the corresponding modeled topographic shade fractions. Building shade is not common in the Project area, and it is not an explicit part of the JSATEMP model. Building shade has been included indirectly in some of the model's terrestrial vegetation shade fractions and in some of the model's bridge shade fractions. Where building shade is included in the model depends on whether the building shade is likely to be present all day long. Building shade in the model can be adjusted in the future by changing the vegetation parameters or bridge shade fractions.

If the modeled shade fractions are substantially (greater than 10%) different from the measured shade fractions, the JSATEMP model parameters will be adjusted. For example, if the measured shade fraction is 0% and the modeled shade is 2%, no adjustment is needed, but if the measured shade fraction is 0% and the modeled shade is 11%, adjustments are necessary. The results of riparian vegetation tree height and SRA cover shaded stream surface indicator monitoring, and measurements and notes for solar heat transfer monitoring provide the basis to modify model shade parameters. Reevaluation of the aerial photographs taken for SRA cover and solar heat transfer monitoring may also be useful for adjusting model shade parameters. A description of these parameters is discussed in appendix H.

6.3.2.2.2 Stream Channel Geometry

Field-measured stream channel geometry values (section 6.2.3) will be compared with stream channel geometry values calculated by the JSATEMP model using the stream flow data collected at the time of the stream channel geometry surveys. The comparison will be made using the steps described in appendix H.

If the modeled depths and widths differ from the field-measured depth and width data by more than 10%, the modeled values should be adjusted by changing the parameters of the width and depth equations, as described in appendix H. Once parameters have been changed, the new estimates of depth and width should again be compared to the field-measured values.

6.3.2.2.3 Stream Flow

Field-measured stream flow will be compared to the stream flow values calculated by the JSATEMP model. The purpose of this comparison is to check the JSATEMP model assumptions for accretions and depletions that occur between the stream gages. To compare field-measured and calculated stream flows, stream flow data collected during stream channel geometry monitoring and during the April–October monthly monitoring (section 6.2.4) will be compared with stream flows estimated by the JSATEMP model using flows at the stream gages on the same dates. If the model flows are more than 10% different from the collected flow data, the accretion/depletion calculations should be modified (appendix H).

6.3.2.3 Run and Evaluate the JSATEMP Stream Temperature Model

The JSATEMP model is ready to be run when

- the time-series data for stream flow, temperature, and meteorology have been inserted into the model;
- stream flow, shade, and channel geometry parameters have been evaluated (if data have recently been collected or conditions have changed);
- the values for model parameters that change monthly (described in appendix H) have been selected; and
- the water temperature and sediment temperature values from the end of the previous month have been entered as the initial values for the current month. This entry can be set up to occur automatically when multiple consecutive months are simulated.

Appendix H provides detailed instructions for running the JSATEMP model.

Prior to simulating Project-related temperature effects, the performance of the model needs to be assessed. Model performance should be assessed when new measured temperature data become available or if parameters in the model are changed. After the October temperatures are downloaded, simulated temperatures for April–October should be compared to the new measured values.

Two tools in the JSATEMP model are used for evaluating results: graphs that compare the measured and simulated water temperatures and tables that summarize the differences between the simulated and measured minimum, mean, and maximum daily water temperatures. Given the variability and uncertainty of model inputs, simulated water temperatures will never exactly match measured temperatures.

Even if model performance is not as accurate as desired, the model is still able to simulate relative differences between water temperatures with and without Project construction. The accuracy of the model could become a concern if temperatures are close to thresholds used in evaluating temperature effects. The short-term thermal suitability index (section 6.5) may be especially sensitive to inaccurate predictions near the threshold temperature. If average monthly differences between simulated and measured temperatures (differences between daily minimum, mean, and maximums) are greater than 1 °F, the sensitivity of the short-term thermal suitability index to the average errors will be assessed.

In previous calibration, the monthly average deviation between the simulated and measured minimum, mean, and maximum daily water temperatures has been 1.4 °F (U.S. Army Corps of Engineers, 2003). The amount of deviation that is acceptable depends on the location of the deviation and the water temperatures relative to requirements of steelhead and Chinook salmon. For example, water temperatures in Alamitos Creek are not important for evaluating Project effects.

Also, when water temperatures are well within the optimal range for steelhead and Chinook salmon, there is little concern about Project effects.

As a general guideline, if the average daily simulated temperatures (minimum, mean, and maximum) for the month are more than 2.5 °F different from the measured temperatures at more than 1 location within model segments 4–6 and 29–39, model adjustment should be attempted. Some general guidelines for adjustments are discussed in appendix H.

In some cases, the model may not be improved because the available information does not enable assessment and resolution of the problem. In such cases, model performance for future months should be carefully monitored to determine whether a trend is present. Currently, model performance evaluation indicates that, for some months, simulated daily temperatures (minimum, mean, and maximum) deviate more than 2 °F from the measured temperatures at some locations. However, for other months, the model accuracy is much better at the same locations.

Model parameters may be modified for 2 reasons. One reason to modify the parameters is to improve the ability of the model to accurately simulate water temperatures. The other reason is to make model parameters more accurately calculate values that agree with field measurements (solar heat transfer, stream channel geometry, and stream flow).

Parameter changes may improve the model for the current month, but the modified model should also be rerun for prior months for which the change in parameters is applicable. For example, if field-measured channel geometry values show that the channel geometry parameters should be modified, the effect of changing channel geometry parameters should be evaluated. First, the likely time of the channel modification should be determined (e.g., the time of a major flow event or Project modification of the low-flow channel). Next, the model should be rerun from that time forward. As another example, collected shade values examined in September may indicate that shade parameters should be changed, but if the shade condition was known to have changed in July as a result of vegetation removal, it is only necessary to reevaluate as far back as July. However, if model reevaluation leads to a change in an inherent feature of the model (such as a change in the equation for solar heat transfer), all prior months should be reevaluated.

When model performance is satisfactory, the simulation of current-postproject conditions is complete.

6.3.3 Simulated Water Temperature—No-Project Conditions

Once the Project has been constructed, simulations will be made to evaluate the impact of the Project on water temperature conditions. Temperature effects will be evaluated by comparing the current-postproject temperatures described above to no-project temperatures described here. To simulate no-project temperatures, the JSATEMP model will be used to simulate water temperatures for present meteorology and stream flow and preproject solar heat transfer and stream channel geometry. To simulate no-project conditions, preproject channel geometry and solar heat transfer conditions must be entered in the model. The preproject parameter values for model segments 30–38 have been entered in the current version of the no-project spreadsheets. These values were derived from the original preproject shade and channel geometry parameters used in the GRR/EIR/SEIS (U.S. Army Corps of Engineers, 2001b), with modifications based on 2001 field measurements (Jones & Stokes, 2002). The preproject parameter values for model segments 5 and 6 (Guadalupe Creek) are the same as those used in the GRR/EIR/SEIS (U.S. Army Corps of Engineers, 2001b).

6.3.4 Data Management and Reporting

The JSATEMP model spreadsheet will be saved using the format “mmmyycpp.wk4,” where

- “mmm” is month (e.g., “Jan”),
- “yy” is year (e.g., “02”), and
- “cpp” or “np” is current-postproject or no-project (e.g., “cpp” for current-postproject conditions and “np” for no-project conditions).

Two new model spreadsheets are created once a year for each month from April–October. JSATEMP model spreadsheets will be backed up on tape and archived on CD.

For the annual mitigation monitoring report, monthly values for minimum, mean, and maximum daily temperatures will be extracted from each model spreadsheet and compiled in a single spreadsheet, so annual plots can be created. The report will include a discussion of model performance that will have graphical and tabular comparisons of simulated and measured temperatures. The report will also contain results from the solar heat transfer, stream channel geometry, and stream flow monitoring conducted during the year and will explain any model adjustments that were made. In addition, the report will include results for the monthly thermal suitability indicator and the short-term thermal suitability indicator, which are both described below.

6.4 Monthly Thermal Suitability Indicator

The monthly thermal suitability indicator is calculated using the water temperature simulated by the JSATEMP model for current-postproject and no-project conditions. Monthly thermal suitability units (TSUs) are calculated for the primary model segments affected by the Project, and then all values are totaled. The monthly thermal suitability index provides a common unit of habitat value that enables accounting for improved water temperature conditions in some stream reaches and degraded water temperature conditions in other stream reaches. The purpose of the monthly thermal suitability indicator is to assess long-term effects of water temperature changes on steelhead and Chinook salmon habitat quality. Water temperature has an important effect on fish growth, reproduction, survival, and migration, especially for steelhead and Chinook salmon, which have relatively narrow temperature requirements for each life stage.

The measurable objective for the monthly thermal suitability indicator is that total monthly TSUs for steelhead and Chinook salmon life stages under postproject conditions equal or exceed no-project TSUs within 40 years of Project construction. In addition, postproject TSUs must indicate a decreasing trend back up to no-project values by 10 years following Project construction (MY 10) (MMP section 4.4.3.2).

6.4.1 Data Collection

No specific data collection requirements are associated with the monthly thermal suitability indicator because it is calculated from JSATEMP model results.

6.4.2 Data Management

Two JSATEMP model spreadsheets, 1 for current-postproject conditions and 1 for no-project conditions, will be prepared once a year for each month from April–October or until temperatures are determined to meet the measurable objectives to the satisfaction of the Adaptive Management Team. These spreadsheets will calculate monthly thermal suitability for each model segment.

For the primary areas affected by the Project (model segments 5, 6, and 30–39), monthly TSUs are calculated for each model segment and then totaled. A summary of monthly TSUs from the current-postproject and no-project spreadsheets will be entered into GEMS.

6.4.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the monthly thermal suitability indicator:

- tblMonthlyThermalSuit (primary data table),
- tblScenario,
- tblFishSpecies,
- tblFishType, and
- tblFishLifeStage.

Figure B-18 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

6.4.2.2 Data Entry

Monthly thermal suitability indices are generated by the JSATEMP model and require no data processing, other than importing results from the JSATEMP model spreadsheets.

6.4.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.4.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- fish species,
- scenario (current-postproject or no-project),
- fish life stage, and
- model segment.

6.4.3 Data Analysis and Evaluation

The JSATEMP model calculates monthly TSUs as described below. To assess whether the monthly thermal suitability measurable objective is being met, the monthly thermal suitability index for current-postproject conditions will be compared to the monthly thermal suitability index for no-project conditions.

6.4.3.1 Calculations

Variables used in calculating the monthly thermal suitability index are defined in table 6-6. The first step in determining the monthly thermal suitability index is to assign suitability indices to the water temperatures for each hour of the month. Suitability indices for each fish life stage are listed in table 6-7. For each model segment, the monthly average suitability index is calculated as the average of the suitability indices associated with each hour of the month. The monthly TSUs for a segment are calculated as

Monthly TSUs = (*monthly average surface area*)(*monthly average suitability index).*

Monthly TSUs for spawning steelhead and Chinook salmon will be calculated using spawning gravel area, as well as monthly average surface area.

Total monthly TSUs are equal to the sum of the monthly TSUs for the model segments affected by Project construction (model segments 5, 6, and 30–39).

$$TotalMonthlyTSUs = \sum_{Segment=5-6,30-39} MonthlyTSUs$$

The maximum possible value for total monthly TSUs equals the monthly average surface area of model segments 5, 6, and 30–39 or, for the case of the assessment that uses spawning gravel, the total spawning gravel area. The total monthly TSUs for current-postproject and no-project conditions are evaluated to determine whether the measurable objective is met.

Table 6-6. Description of JSATEMP Stream Temperature Model Variables Used for the Monthly Thermal Suitability Indicator

Variable	Definition	Comments
Stream surface area (acres)	Monthly average width multiplied by the length of a stream segment.	Stream width estimates depend on stream flow and will be corroborated with measured width data as part of monitoring activities (section 6.2.3).
Spawning gravel area	Surface area of spawning gravel in each model segment	Determined by methods described in section 7.2.1
Suitability index (SI)	Unitless number between 0 and 1 that indicates the suitability of a water temperature for a particular life stage; 0 indicates that the life stage would not survive and 1 indicates optimal temperature conditions for life stage survival (Fris and DeHaven, 1993, U.S. Fish and Wildlife Service, 1982).	The SI values assigned to each water temperature are shown in table 6-7 for each species and life stage. For example, a water temperature of 70 °F would be assigned an SI value of about 0.5 for juvenile steelhead, juvenile Chinook salmon, and smolt Chinook salmon; an SI value of 0.26 for adult Chinook salmon; and an SI value of 0.00 for Chinook salmon eggs and steelhead smolt, adults, and eggs.
Monthly average suitability index	Average of all SIs assigned to simulated water temperatures for each hour of a month for each model segment analyzed.	
Monthly thermal suitability units (Monthly TSUs)	Monthly average stream surface area or gravel area multiplied by the monthly average SI for the model segment.	Monthly TSUs are calculated for each model segment in the areas affected by the Project (model segments 5, 6, and 30–39).
Total monthly thermal suitability units (Total monthly TSUs)	Sum of monthly TSUs for the stream reaches affected by the Project.	These stream reaches are represented in the JSATEMP model as model segments 5, 6, and 30–39.

Table 6-7. Suitability Indices for Water Temperature Effects on All Life Stages of Steelhead and Chinook Salmon

Water Temperature (ºF)	Suitability Indices							
	Steelhead				Chinook Salmon			
	Juvenile	Smolt	Adult	Eggs	Juvenile	Smolt	Adult	Eggs
53	1	1	1	1	1	1	1	1
54	1	1	1	0.88	1	1	0.96	1
55	1	1	1	0.75	1	1	0.91	1
56	1	1	1	0.63	1	1	0.87	1
57	1	1	1	0.5	1	1	0.83	1
58	1	1	0.88	0.38	1	1	0.78	0.75
59	1	1	0.75	0.25	1	1	0.74	0.5
60	1	1	0.63	0.13	1	1	0.7	0.25
61	1	0.86	0.5	0	1	1	0.65	0
62	1	0.69	0.38	0	1	1	0.61	0
63	1	0.52	0.25	0	1	1	0.57	0
64	1	0.36	0.13	0	1	1	0.52	0
65	0.92	0.19	0	0	0.92	0.92	0.48	0
66	0.85	0.02	0	0	0.83	0.83	0.43	0
67	0.77	0	0	0	0.75	0.75	0.39	0
68	0.69	0	0	0	0.67	0.67	0.35	0
69	0.62	0	0	0	0.58	0.58	0.3	0
70	0.54	0	0	0	0.5	0.5	0.26	0
71	0.46	0	0	0	0.42	0.42	0.22	0
72	0.38	0	0	0	0.33	0.33	0.17	0
73	0.31	0	0	0	0.25	0.25	0.13	0
74	0.23	0	0	0	0.17	0.17	0.09	0
75	0.15	0	0	0	0.08	0.08	0.04	0
76	0.08	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0

Based on Raleigh et al., 1984, 1986; Rich 1987.

6.4.3.2 Statistical Analysis Methods

Total monthly TSUs for current-postproject and no-project conditions for April–October will be presented in tables and/or graphs for each species' life stage.

The overall area-weighted monthly average SI can be determined by dividing the total monthly TSUs by the total stream surface area.

6.4.3.3 Quality Assurance

Measured water temperature values are compared with simulated water temperature values to ensure the accuracy and reliability of the JSATEMP model results. The JSATEMP model will calculate the monthly TSUs directly from the simulated temperatures. *Total monthly TSUs* should not be greater than the surface area of the portion of the river and creek being evaluated (model segments 5, 6, and 30–39).

6.4.3.4 Comparison to Measurable Objective

The measurable objective for the monthly thermal suitability indicator requires that total monthly TSUs for steelhead and Chinook salmon life stages under current-postproject conditions equal or exceed no-project total monthly TSUs within 40 years of Project construction. The difference between no-project TSUs and current-postproject TSUs must indicate a decreasing trend back to no-project values by year 10.

Although the monthly thermal suitability indicator does not need to meet a measurable objective until 40 years after Project construction, it will be included in each annual mitigation monitoring report to the Adaptive Management Team. To report the results on an annual basis, monthly TSU values will be extracted from the monthly spreadsheet models and imported into a single spreadsheet. The report will include tables and/or graphs showing total monthly TSUs for each life stage for both current-postproject and no-project conditions. Figure 6-8 is shown as an example of such a figure that was created using simulations for evaluating Project temperature effects for the GRR/EIR/SEIS (U.S. Army Corps of Engineers, 2001b). Note that for this figure, the no-project and current-postproject stream surface areas were assumed to be the same even though, in reality, current-postproject stream surface area is expected to be less than no-project stream surface area.

To help assess Project effects, the decrease in total monthly TSUs will also be presented as a percentage of the total available acres. For example, in figure 6-8, there were 14.4 total available acres for August. If all water temperatures were in the optimal range, 14.4 acres would be the value for the total monthly TSUs. However, because the overall average SI score was 0.38 for current-postproject conditions and 0.56 for no-project conditions, the value for the total monthly TSUs is only 5.4 acres (38% of the 14.4 possible) for current-postproject conditions and 8.0 acres (56% of the 14.4 possible) for no-project conditions. The 2.6-acre drop in August TSUs represents 18% of the total possible value.

6.5 Short-Term Thermal Suitability Indicator

The short-term thermal suitability indicator is used to assess the surface area of stream that provides suitable water temperatures for each life stage of steelhead and Chinook salmon. This short-term thermal suitability indicator enables the Adaptive Management Team to determine the need for remedial actions in the short term, prior to the maturation of SRA cover vegetation and riparian vegetation mitigation areas.

The suitability of water temperature is determined separately for each model segment, using the simulated monthly median water temperature for each model segment. Model segments are designated as either suitable or unsuitable. Total suitable surface area is determined as the sum of the areas of all the model segments that meet the suitability criteria. To evaluate the temperature effects on spawning steelhead and Chinook salmon, the total suitable area will be calculated 2 ways: using water surface area and using spawning gravel area. The total suitable area for the areas affected by the Project (model segments 5, 6, and 30–39) is the value used for evaluating the measurable objective. To meet the measurable objective for the short-term thermal suitability indicator, the area with suitable temperatures under postproject conditions must be equal to or greater than 50% of the area that would have provided suitable water temperatures under no-project conditions for current stream flow and meteorology (MMP section 4.4.3.3). The postproject conditions evaluated are current-postproject conditions and postproject conditions predicted for the subsequent year (future-postproject).

The difference between the monthly thermal suitability indicator and the short-term thermal suitability indicator is that the monthly thermal suitability indicator allows assessment of the trend in habitat quantity and quality relative to no-project habitat. The short-term thermal suitability indicator identifies potential adverse effects prior to the growth of mitigation plantings that would cool water temperature. A small increase in temperature may have little effect on the monthly thermal suitability indicator but could cause a failure to meet the short-term thermal suitability measurable objective. This sensitivity of the short-term measurable objective occurs when no-project temperatures are close to the thresholds that indicate unsuitable temperature conditions.

The short-term thermal suitability indicator is only evaluated for the months of April–October (the months when water temperature is being monitored at all locations). During most of the remaining months, water temperature effects associated with Project construction are small and water temperatures are usually within acceptable ranges for anadromous fish (U.S. Army Corps of Engineers, 2001b).

The measurable objective for the short-term thermal suitability indicator will be assessed annually and presented in the annual mitigation monitoring report at the beginning of each year. In addition, the report will include a prediction of the next year’s short-term thermal suitability indicator based on construction plans for the next year.

6.5.1 Data Collection

No specific data collection requirements are associated with the short-term thermal suitability indicator because the suitability indicator is derived from JSATEMP model results.

6.5.2 Data Management

Three JSATEMP model spreadsheets, 1 for current-postproject conditions, 1 for future-postproject conditions, and 1 for no-project conditions, will be prepared once a year for each month in April–October for at least 10 years following Project construction (MYs 1–10) or until temperatures are determined to meet the measurable objectives to the satisfaction of the Adaptive Management Team. These spreadsheets will calculate suitable area for each model segment. A summary of short-term thermal suitability from the current-postproject, future-postproject, and no-project spreadsheets will be entered into the RDBMS of GEMS.

6.5.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the short-term thermal suitability indicator:

- tblShortTermSuit (primary data table),
- tblScenario,
- tblFishSpecies,
- tblFishType, and
- tblFishLifeStage.

Figure B-19 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

6.5.2.2 Data Entry

Short-term thermal suitability results are generated by the JSATEMP model and require no data entry, other than importing results from the model spreadsheets. The final short-term thermal suitability index, however, must be generated using suitable areas from the current-postproject and no-project spreadsheets. This value does not need to be entered in the RDBMS because it can be calculated from the other values within the RDBMS.

6.5.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

6.5.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- scenario (current-postproject, future-postproject, or no-project),
- model segment,
- fish species, and
- fish life stage.

6.5.3 Data Analysis and Evaluation

The JSATEMP model calculates the components of the short-term thermal suitability index (appendix H). The calculation procedure used by the model is described below.

6.5.3.1 Calculations

The short-term thermal suitability index is calculated using water temperatures from the stream segments affected by the Project, which are model segments 5, 6, and 30–39. The short-term thermal suitability index is calculated using the following steps for current-postproject, future-postproject, and no-project water temperatures.

1. The JSATEMP model calculates the monthly median of hourly water temperatures for model segments 5, 6, and 30–39. If the median temperature for a model segment is less than or equal to the maximum suitable water temperature (listed by life stage in table 6-8), the model segment is considered suitable for the respective species and life stage. The maximum suitable water temperatures are the highest temperatures that have an SI value greater than or equal to 0.5.
2. The JSATEMP model determines the average surface area of each model segment for the month being evaluated.
3. The JSATEMP model calculates the total suitable area for each steelhead and Chinook salmon life stage that may be present in the river for the month being evaluated for model segments 5, 6, and 30–39. Potential presence of a life stage is based on general life history data and observations in the Guadalupe River.

4. Calculate the short-term thermal suitability index for each fish species and life stage as

$$100 \times \frac{\textit{postproject total suitable area}}{\textit{no-project total suitable area}}$$

Notes: Postproject total suitable area is for current-postproject or future-postproject temperatures, depending on what is being evaluated.

The values for current-postproject suitable area, future-postproject suitable area, and no-project suitable area are found in the current-postproject, future-postproject, and no-project spreadsheets.

Table 6-8. Maximum Suitable Water Temperatures (°F) for Each Life Stage of Steelhead and Chinook Salmon. (These values represent the highest water temperatures that have an SI score greater than or equal to 0.5.)

	Steelhead				Chinook Salmon			
Month	Juvenile	Smolt	Adult	Eggs	Juvenile	Smolt	Adult	Eggs
Jan	70	63	61	57	70	–	–	59
Feb	70	63	61	57	70	70	–	59
Mar	70	63	61	57	70	70	–	59
Apr	70	63	61	57	70	70	–	–
May	70	63	–	57	70	70	–	–
Jun	70	63	–	–	70	70	–	–
Jul	70	–	–	–	–	–	–	–
Aug	70	–	–	–	–	–	64	–
Sep	70	–	–	–	–	–	64	–
Oct	70	–	–	–	–	–	64	59
Nov	70	–	61	–	–	–	64	59
Dec	70	–	61	–	–	–	64	59

Note: – indicates the life stage would not be present in the Guadalupe River.

6.5.3.2 Statistical Analysis Methods

No statistical analysis is required to analyze the short-term thermal suitability indicator.

6.5.3.3 Quality Assurance

Measured water temperature values are compared with simulated water temperature values to ensure the accuracy and reliability of the JSATEMP model. The JSATEMP model will calculate the short-term thermal suitability values directly from the simulated temperatures. The total suitable surface areas should not be greater than the surface area of the portion of the stream being evaluated (model segments 5, 6, and 30–39).

If the average monthly differences between simulated and measured temperatures (differences between daily minimums, means, and maximums) are more than 1 °F at 1 or more of the locations included in the short-term thermal suitability index, the sensitivity of the index to the errors will be assessed. The sensitivity will be analyzed by adjusting the simulated temperatures by the error value and recalculating the index value. For model segments located between temperature measurement sites, the error term will be linearly interpolated using the error terms for the 2 nearest measurement sites. This sensitivity analysis is recommended because the short-term thermal suitability index is based on temperature thresholds, thereby making the index sensitive to the accuracy of the model predictions when temperature is close to the threshold.

6.5.3.4 Comparison to Measurable Objective

To meet the measurable objective for the short-term thermal suitability indicator, the area with suitable water temperatures under current-postproject or future-postproject conditions must be equal to or greater than 50% of the area that would have provided suitable water temperatures under no-project conditions.

For example, the suitable temperature in July is 70 °F for juvenile steelhead, the only species and life stage present. In this example, assume that for model segments 5, 6, and 30–39, the total stream surface area with median water temperatures less than or equal to 70 °F is 10 acres under no-project conditions. The total stream surface area with median water temperatures less than or equal to 70 °F must be at least 5 acres for current-postproject conditions to meet the measurable objective for the short-term thermal suitability indicator for juvenile steelhead habitat.

The short-term thermal suitability indicator will be assessed annually after the October water temperatures have been measured. In addition, the short-term thermal suitability indicator will be assessed using predictive analysis of future-postproject effects for the subsequent year (e.g., WY 2003 in the WY 2002 MMR). The short-term thermal suitability indicator will be simulated for April–October. For example, in the WY 2002 MMR, no-project water temperature is the temperature that would have occurred in WY 2002 if stream channel geometry and shade had not been affected by the Project. Current-postproject water temperature is the temperature that occurred in WY 2002. Future-postproject water temperature is the temperature that would have occurred if Project elements planned for WY 2003 had been implemented in WY 2002.

The future short-term thermal suitability indicator will be evaluated for the hydrology and meteorology of the current year. However, meteorology can vary from year to year, and the short-term thermal suitability indicator predicted for the future year may not represent conditions that would actually occur in the future year. Available historical air and water temperature data will be used to evaluate the potential to achieve the measurable objective for the short-term thermal suitability indicator over the historical range of temperatures. Stream flows for April–October are likely to be similar from year to year, so the effect of annual variation in flow on the predictions of future water temperature will not be evaluated.

If the measurable objective for the short-term thermal suitability indicator is not achieved for either the current-postproject or the future-postproject water temperatures, potential remedial actions will be identified and recommended by the Adaptive Management Team. If it appears that the measurable objective will not be met in the subsequent year, actions that would avoid or minimize Project warming of water could be implemented in advance. The Adaptive Management Team may decide, however, that no remedial action is necessary because the temperature increases that caused the thresholds to be exceeded were very small or because only a small area of river became unsuitable as a result of the Project or because few fish are present. The Adaptive Management Team may also decide to modify the triggers for meeting the measurable objective for short-term thermal suitability. If the measurable objective for the monthly thermal indicator is met by year MY 10, the Adaptive Management Team will determine whether use of the short-term thermal suitability indicator should continue.

Chapter 7
Anadromous Fish Spawning Habitat

Spawning gravel

7.1 Introduction

Indicators for anadromous fish spawning habitat are

- spawning gravel abundance and
- spawning gravel quality.

The target species for these indicators are steelhead and Chinook salmon.

Data collection, data management, and data analysis and evaluation are discussed for each indicator in later sections of this chapter.

7.1.1 Staff Qualifications

To successfully complete data collection, data management, and data analysis and evaluation requirements associated with the anadromous fish spawning habitat indicators, the following minimum qualifications for staff conducting the work are recommended.

7.1.1.1 Data Collection

Data collection should be performed by staff members with a related 4-year college degree (e.g., fish biology or biology) and 2 years professional experience in fish field surveys. Specifically, it is suggested that the staff members have experience with

- use of various fish and fish habitat sampling techniques,
- interpretation of aerial photographs, and
- use of aerial photographs as a field mapping base.

The data collection methods for most indicators assume that the work will be conducted by a 2-person monitoring team to facilitate safe and efficient data collection. When 2-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

7.1.1.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft SQL relational databases.

7.1.1.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in the design and analysis of biological field studies, including regression analysis.

7.2 Spawning Gravel Abundance Indicator

The anadromous fish spawning habitat spawning gravel abundance indicator represents the area of rounded river gravel in patches at least 3 feet in diameter and 0.5 foot deep. The purpose of monitoring this indicator is to identify the amount of suitable substrate that is available to anadromous fish for spawning and to identify loss of spawning gravel attributable to the Project. Gravel substrates support the spawning of steelhead, Chinook salmon, Pacific lamprey (*Lampetra tridentata*), and other species.

The measurable objective for the spawning gravel abundance indicator for Segments 1, 2, 3A, 3B, and 3C, and the Woz Way to Park Avenue Bypass is that spawning gravel must be replaced when spawning gravel coverage drops below 20,000 square feet and when spawning gravel is replaced, it must be in an amount sufficient to bring total spawning gravel coverage to 25,190 square feet. In addition, cumulative postproject spawning gravel abundance at a given elevation must be at least 75% of the preproject abundance at the same elevation (MMP section 4.5.3.1). Because preproject elevational data were not available at the resolution necessary for Segments 1, 2, 3A, 3B, and 3C, and the Woz Way to Park Avenue Bypass, postproject data collected in WY 2001 (for every segment except Segment 3C) and WY 2003 (for Segment 3C) are used in place of preproject data.

The measurable objective for the spawning gravel abundance indicator for Reach A and Guadalupe Creek is that 80% of WY 2001 and WY 2003 gravel coverage, respectively, be maintained. In addition, cumulative spawning gravel abundance at a given elevation must be at least 75% of the abundance at the same elevation in WY 2001 and WY 2003, respectively.

7.2.1 Data Collection

7.2.1.1 Permit Requirements

No permits are required for conducting the spawning gravel abundance monitoring described below.

7.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs of Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek, printed at a scale of 1 inch = 50 feet;
- depth rod (at least 4 feet long with divisions to 0.1 foot, preferably a top-setting rod);
- ruler in metric units (to assist in estimating gravel size);
- 100-foot measuring tape;
- plastic bucket (12-inch diameter);
- shovel (can be small, collapsible style);
- chest waders and life jackets (for each team member);

- wading staff (for stability and identifying deep water); and
- data collection form FISH-01 (at least 1 form per day; appendix D).

7.2.1.3 Schedule

The spawning gravel abundance indicator will be monitored once a year in June–October for 5 monitoring years following Project construction (MYs 1–5) and, if the Adaptive Management Team determines that additional monitoring is needed, every fifth year thereafter through MY 40 (MYs 10, 15, 20, 25, 30, 35, and 40) (chapter 2). Spawning gravel abundance monitoring will also occur prior to Project construction in Reach A and Guadalupe Creek. Spawning gravel abundance data will be collected simultaneously with spawning gravel quality data.

7.2.1.4 Location and Access

Spawning gravel abundance monitoring will be conducted in potential spawning habitat, including riffles, runs, and pool tailouts, in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

7.2.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor spawning gravel abundance. These steps are described in detail later in this chapter.

To monitor spawning gravel abundance, the monitoring team will

- monitor stream flows using data posted on the SCVWD web site,
- identify suitable spawning gravel beds to be monitored,
- visually estimate the elevation of the gravel bed relative to the current water surface elevation to determine whether the gravel will be inundated during anadromous fish spawning periods,
- measure average gravel bed length and width,
- measure gravel bed depth,
- measure gravel size,
- record the location of each gravel bed on the aerial photographs, and
- record gravel abundance data on data collection form FISH-01.

7.2.1.5.1 Mapping and Documentation

In the Office

1. Obtain stream flow data for the area to be surveyed from stream gages located in the vicinity. Stream flow data can be accessed on the Internet at alert.valleywater.org/gagestrm.html.

   - For the Guadalupe River, use the USGS gage on the Guadalupe River upstream of the Highway 101 bridge (gage number 11169025).
   - For Guadalupe Creek, use the SCVWD gage downstream of Guadalupe Reservoir (gage number 17).

   Note: Always field-verify gage readings by visually estimating flow in the segments monitored. If visual flow estimates differ substantially from gage data reported on the SCVWD web site, measure flow in the field and contact the SCVWD to report the difference.

2. Mark the location of redds identified in the previous water year's adult migration and spawning surveys on the aerial photographs.
3. Mark the location of gravel placed since the last high flows on the aerial photographs. Placed gravel should not be included with the monitoring of native gravel in the first monitoring season after it is placed. The quality and quantity of placed gravel is monitored immediately after it is placed.

In the Field

4. Begin monitoring at the downstream end of the stream segment to be monitored.

   - For the Guadalupe River, begin monitoring at the Airport Parkway bridge in Reach A and continue monitoring through Grant Street at the upstream end of Segment 3C.
   - For Guadalupe Creek, begin monitoring at Almaden Expressway bridge and continue monitoring through Masson Dam.

5. Indicate the geographic location of the start point and end point for each monitoring day on the data collection form.
6. Identify all suitable spawning gravel beds to be monitored. Suitable spawning gravel beds

   - have a minimum area of 10 square feet and are at least 6 inches deep (depth refers to thickness of gravel layer),
   - are not armored with cobbles or rocks greater than 6 inches in any dimension, and

- contain gravel sizes ranging from 0.25 to 4.0 inches in diameter and average 2.0 inches in diameter.

Note: Although they may not meet the definition of suitable spawning gravel beds, gravel beds that were identified as supporting redds in the previous water year's adult migration and spawning surveys should also be monitored.

7. Record the location of the gravel bed on the aerial photographs, and provide a narrative location description on the data collection form.
8. Use the following alpha-numeric naming convention to label each gravel bed: water year, 4-letter abbreviation for gravel bed, and a consecutive number for each gravel bed, beginning with 001. For example, the first gravel bed for WY 2001 would be labeled 01-GRAV-001.
9. Visually estimate the percentage of gravel within each foot of contour elevation (elevational unit) (figure 7-1).

Note: An elevational unit is used to determine what portion of a gravel bed will be inundated during anadromous fish spawning periods.

a. Establish a cross section through the gravel bed by stretching a measuring tape across the gravel bed, making sure that the cross section generally encompasses all elevations of the gravel bed.

b. Measure the average length and width of the gravel bed in feet, and record the measurement on the data collection form.

c. Determine the lowest point of the cross section relative to the stream surface by walking along the cross section and measuring water depth at regular intervals with a depth rod.

d. Beginning at the lowest point along the cross section, visually estimate the percentage of gravel (to the nearest whole percent) in each elevational unit (figure 7-1) and, record the estimate on the data collection form. Elevational units are relative to the stream water surface and describe the elevation of the gravel in 1-foot increments. Negative numbers designate elevational units below the water surface, positive numbers designate elevational units above the water surface, and 0 is the water surface. For example, elevational unit -3 to -2 is between 2 and 3 feet below the water surface, and elevational unit 0 to +1 is between 0 and 1 foot above the water surface. The percentages in the elevational units are not cumulative, that is, they are not added to the percentage in the adjacent elevational unit.

10. Measure the depth (i.e., thickness) of the gravel bed.

a. Dig a 6-inch diameter hole or larger in what appears to be the deepest (i.e., thickest) part of the gravel bed, and place the gravel excavated from the hole in a bucket. The depth of the hole should be at least 6 inches or, if less, excavated to a point where the gravel becomes too embedded to remove. If the gravel sample is under water, the mouth of the bucket should be just downstream of the excavated hole to capture all material that may be mobilized by stream flow.

b. Measure the depth of the hole (gravel bed depth) to the nearest 0.1 foot, and record the measurement on the data collection form.

Note: Gravel excavated for this survey should be set aside for use in the spawning gravel quality indicator monitoring (section 7.3.1.5.1).

11. Visually estimate the average size of gravel found in the gravel bed. Record on the data collection form the corresponding gravel class, as listed in table 7-1.

Table 7-1. Classification of Gravel by Average Size

Gravel Class	Average Size [millimeters (inches)]
Fine gravel	6–25 (0.25–1)
Medium gravel	26–50 (1.1–2.0)
Coarse gravel	51–75 (2.1–3.0)
Small cobble	76–102 (3.1–4.0)

12. Conduct the spawning gravel quality assessment described in the following section (7.3).
13. Repeat for all gravel beds.

7.2.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the spawning gravel abundance indicator.

7.2.2 Data Management

Spawning gravel abundance data will be collected once a year in June–October for 5 years following Project construction (MYs 1–5) and, if the Adaptive Management Team determines that additional monitoring is needed, every fifth year thereafter through MY 40 (MYs 10, 15, 20, 25, 30, 35, and 40). Spawning gravel abundance data are recorded on the FISH-01 data collection form. This indicator is recorded for each suitable spawning gravel bed. Spawning gravel abundance data are stored in GEMS: data collected on data collection form FISH-01 are entered in the RDBMS, and data collected on aerial photographs are entered in the GIS database.

7.2.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the spawning gravel abundance indicator:

- tblSpawnGravAbund (primary data table),
- tblStreamSegment,
- tblStartPoint,
- tblEndPoint,
- tblStreamGage,
- tblGravelBed,
- tblStream,
- tblPhotos,
- tblSGAGravel,
- tblGravelClass,
- tblSGATeam, and
- tblMembers.

Figure B-20 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

7.2.2.2 Data Entry

Data from the FISH-01 data collection forms will being to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

7.2.2.3 Data Structure and Entry for Aerial Photographs

Suitable spawning gravel beds will be mapped as a point on aerial photographs. This field data will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points will be attributed with gravel bed identification numbers. All points for a given monitoring year will be included in 1 shapefile named "Anadromous_Fish_Spawning_Habitat_Spawning_Gravel_mmmyy," where "mmm" is month (e.g., "jan") and "yy" is year (e.g., "01").

7.2.2.4 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

7.2.2.4.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream gage,
- gravel bed,
- stream segment, and
- gravel class.

7.2.3 Data Analysis and Evaluation

The analysis and evaluation of the spawning gravel abundance monitoring data assesses whether the 3 components of the measurable objective are being met:

- 20,000 square feet of spawning gravel in Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass combined and at least 75% of preproject cumulative spawning gravel abundance at a given elevation (cumulative abundance is calculated beginning with the lowest elevation relative to the stream channel bottom);
- 80% of WY 2001 gravel coverage in Reach A (i.e., 5,340 square feet of spawning gravel); and
- 80% of WY 2003 gravel coverage in Guadalupe Creek (i.e., 1,972 square feet of spawning gravel).

In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

7.2.3.1 Calculations

Calculate the following variables for gravel beds in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek; and all stream segments combined.

- *Total spawning gravel area.* Multiply the width and length of each gravel bed to determine its area, and sum the areas of all gravel beds in each stream segment and all stream segments combined.

- *Total cumulative spawning gravel area in each elevational unit.* Multiply the cumulative percentage of spawning gravel in each elevational unit in each gravel bed by the total area of each gravel bed to determine the cumulative area of spawning gravel in each elevational unit. Sum the area of spawning gravel in each elevational unit in each stream segment and all stream segments combined.

7.2.3.2 Statistical Analysis Methods

Prepare the following graphs.

- *Total area of spawning gravel for each stream segment* and *all stream segments combined* for comparison to *all other monitoring years*. Show a horizontal line at the measurable objective (i.e., 20,000 square feet of spawning gravel).
- *Total cumulative area of spawning gravel in each elevational unit for each stream segment* and *all stream segments combined* for the current monitoring year and for preproject conditions. Show a horizontal line at the measurable objective for each elevational unit (i.e., 75% of preproject cumulative abundance).

7.2.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **The sum of the percentage of gravel at each elevational unit is equal to 100%.** Verify that the sum of the percentage of gravel at each elevational unit is equal to 100%. If it is not equal to 100%, check for errors on data collection form FISH-01. If necessary, examine the gravel bed in the field and determine whether the percentages are correct. Correct data collection form FISH-01 and GEMS, as appropriate.

7.2.3.4 Comparison to Measurable Objective

Identify changes in gravel abundance by location and potential causes for change in abundance. In Segments 1, 2, 3A, 3B, and 3C and the Woz Way to Park Avenue Bypass, if the total spawning gravel abundance is less than 20,000 square feet (including gravel placed as a remedial action), identify the cause of reduced abundance, the estimated replacement gravel needed to bring total gravel abundance up to 25,190 square feet, and possible remedial actions that could be implemented to increase spawning gravel abundance. If at least 75% of preproject cumulative spawning gravel abundance at a given elevation is not present, identify the cause of reduced abundance at that elevation and possible remedial actions that could be implemented to increase spawning gravel abundance at that elevation.

If gravel coverage in Reach A is not maintained at or above 5,340 square feet and gravel coverage in Guadalupe Creek is not maintained at 1,972 square feet, identify the cause of reduced abundance and the estimated replacement gravel needed to bring total gravel coverage to 5,340 square feet for Reach A and 1,972 square feet for Guadalupe Creek. Decreased gravel abundance should be considered in context with the past 3–5 years of data. Identify possible remedial actions that could be implemented to increase spawning gravel abundance. Based on gravel abundance in MY 5 and variability in gravel abundance over the previous 3–5 years, discuss recommendations for future monitoring.

If remedial actions are deemed necessary and spawning gravel is augmented with placed gravel, the quantity and quality of the placed gravel must be measured immediately after the gravel is placed. Abundance and quality should be measured using the methods described in this chapter (sections 7.2.1 and 7.3.1).

7.3 Spawning Gravel Quality Indicator

The anadromous fish spawning habitat spawning gravel quality indicator represents the sizes and embeddedness of gravel particles within spawning gravel beds. Embeddedness is the degree to which large particles (i.e., gravel, cobbles, and boulders) are surrounded or covered by fine sediment (i.e., sand, silt, and clay). The purpose of monitoring this indicator is to ensure that the Project does not cause an increase in the proportion of fine sediment and degradation of existing spawning gravel quality. Steelhead and Chinook salmon require relatively clean gravel in which to spawn. Filling the smaller spaces between gravel particles with silt and sand (i.e., an increase in embeddedness) can reduce the flow of water and oxygen to eggs and larvae in the gravel beds and can reduce or prevent fry or young fish from emerging after they have hatched. The measurable objective for the spawning gravel quality indicator is that spawning gravel quality must meet or exceed preproject conditions (MMP section 4.5.3.2). Because preproject quality data were not available at the resolution necessary, postproject data collected in WY 2001 (for every segment except Segment 3C) and WY 2003 (for Segment 3C and Guadalupe Creek) are used in place of preproject data.

7.3.1 Data Collection

7.3.1.1 Permit Requirements

No permits are required for conducting the spawning gravel quality monitoring described below.

7.3.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- shovel (can be small, collapsible style),
- plastic bucket (12-inch diameter),
- sampling grid (a clear plastic sheet with 9 squares in each row and each column that forms eighty-one 5-centimeter squares and has lines intersecting at 100 points),
- metric ruler (to assist in estimating gravel size),
- high-resolution digital camera,
- dark-colored tarp,
- chest waders and life jackets (for each team member), and
- data collection form FISH-02 (at least 1 form per day; appendix D).

7.3.1.3 Schedule

The spawning gravel quality indicator will be monitored once a year in June–October for 5 monitoring years following Project construction (MYs 1–5) and, if the Adaptive Management Team determines that additional monitoring is needed, every fifth year thereafter through MY 40 (MYs 10, 15, 20, 25, 30, 35, and 40) (chapter 2). Spawning gravel quality monitoring will also occur prior to Project construction in Reach A and Guadalupe Creek. Spawning gravel abundance data will be collected simultaneously with spawning gravel quality data.

7.3.1.4 Location and Access

Spawning gravel quality monitoring will be conducted in riffles, runs, and pool tailouts in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). In addition, monitoring will be conducted upstream of the Project area in the mainstem of the Guadalupe River from Grant Street to the Alamitos drop structure (Upper Guadalupe River) and in Los Gatos Creek from the confluence to Bascom Avenue (Los Gatos Creek). Access to these areas requires coordination with the SCVWD.

7.3.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor spawning gravel quality. These steps are described in detail later in this chapter.

To monitor spawning gravel quality, the monitoring team will

- excavate samples at least 6 inches in diameter by 6 inches deep from suitable gravel beds identified during the spawning gravel abundance monitoring,

- numerically categorize the gravel by quality category,
- photograph each quality sample, and
- record spawning gravel quality data on data collection form FISH-02.

7.3.1.5.1 Mapping and Documentation

In the Field

1. Use the material excavated for the spawning gravel abundance indicator.

   Note: For sites upstream of the Project area (i.e., Upper Guadalupe River and Los Gatos Creek), use the procedures described for spawning gravel abundance in section 7.2.1.5.1 to select suitable monitoring locations (step 6), record the locations (steps 7 and 8), and dig a hole (step 10a).

2. Record the gravel bed identification number on the data collection form.
3. Spread the material excavated for the spawning gravel abundance indicator evenly over the tarp.
4. Photograph the sample with a high-resolution digital camera (remember to place the ruler in the frame for scale perspective), and record the digital image number on the data collection form.
5. Overlay the gravel sample that is spread on the tarp with the sampling grid.
6. On the data collection form, record the category for the size of each particle (table 7-2) that lies under each point of line intersection on the grid (figure 7-2). Keep a tally of the number of particles in each size category, then sum the total number of particles within each size category, and record the totals for each particle size category on the data collection form. Some of the line intersection points may be over areas on the tarp without gravel; the amount of gravel on the tarp should be sufficient to provide at least 85 particle measurements.

Table 7-2. Numeric Categories of Substrate Particle Size for Steelhead and Chinook Salmon Spawning Habitat

Particle Size		
Inches	Millimeters	Category
<0.08	<2	1
0.08–0.2	2–5	2
0.3–1.0	6–25	3
1.1–4.0	26–102	4
4.1–6.0	103–150	5

Modified from Crouse et al. 1981.

7. Backfill the excavated hole with the original material.
8. Repeat for all gravel samples excavated during gravel abundance monitoring.

In the Office

9. Download digital images from the digital camera for filing in GEMS.

7.3.1.6 Immediate Remedial Actions Required

No immediate remedial actions are required for the spawning gravel quality indicator.

7.3.2 Data Management

Anadromous fish spawning habitat spawning gravel quality data will be collected once a year in June–October for 5 years following Project construction and, if the Adaptive Management Team determines that additional monitoring is needed, every fifth year thereafter through MY 40 (MYs 10, 15, 20, 25, 30, 35, and 40). Spawning gravel quality data are recorded on the FISH-02 data collection form. This indicator is recorded for each suitable spawning gravel bed. Spawning gravel quality data are stored in the RDBMS of GEMS.

7.3.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the spawning gravel quality indicator:

- tblSpawnGravQ (primary data table),
- tblStreamSegment,
- tblStartPoint,
- tblEndPoint,
- tblGravelBed,
- tblSGQTeam, and
- tblMembers.

Figure B-21 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

7.3.2.2 Data Entry

Data from the FISH-02 data collection forms will be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

7.3.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

7.3.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream segment,
- gravel bed, and
- gravel class.

7.3.3 Data Analysis and Evaluation

The analysis and evaluation of the spawning gravel quality monitoring data assesses whether the measurable objective of meeting or exceeding initial postproject spawning gravel quality conditions will be met. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

7.3.3.1 Calculations

Calculate the following variables.

- *Average percent fines* for all samples in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek; and all stream segments combined (do not include gravel beds monitored in the Upper Guadalupe River and Los Gatos Creek in this calculation). The fines include the percentage of particles in particle size categories 1 and 2 combined (i.e., a particle size less than 0.2 inch [5 millimeters]).
- A*verage percent fines* for gravel beds in the Upper Guadalupe River and Los Gatos Creek and in the Upper Guadalupe River and Los Gatos Creek combined.

7.3.3.2 Statistical Analysis Methods

Prepare the following graph:

- *average percent fines for each stream segment* versus *monitoring year*.

7.3.3.3 Quality Assurance

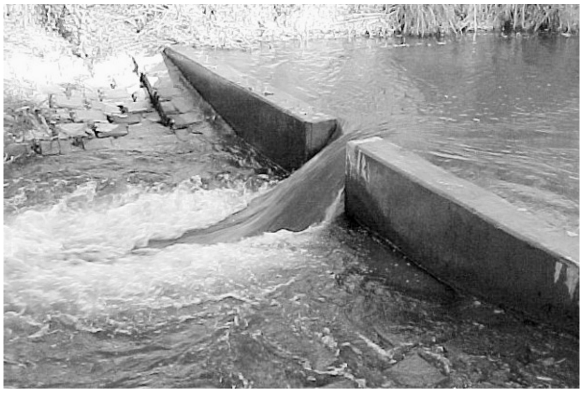
Verify the basic level of accuracy of the data by checking the following.

- **The sum of the number of particles of all size categories is less than or equal to 100.** Verify that the sum of the number of particles of all size categories is less than or equal to 100. If it is greater than 100, check for errors on data collection form FISH-02. If necessary, examine the digital image of the gravel and determine whether the counts are correct. Correct data collection form FISH-02 and GEMS, as appropriate.

7.3.3.4 Comparison to Measurable Objective

Based on the graph of *average percent fines* versus *monitoring year*, note any changes in gravel quality by stream segment (i.e., Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek). If the average percent fines for a stream segment increases by more than 5% relative to initial postproject surveys and the increase (when considered in context with the past 3–5 years of data) indicates a trend or permanent change in conditions, identify the potential cause of reduced quality. If the cause is attributable to the Project, identify potential remedial actions. Compare average percent fines in the Project area to values upstream of the Project area in the Upper Guadalupe River and Los Gatos Creek. Similar values might indicate that the source of fines is not Project-related, whereas lower values in upstream areas might indicate that the source of fines is Project-related. Based on gravel quality in MY 5 and variability in gravel quality over the previous 3–5 years, discuss recommendations for future monitoring.

Chapter 8
Anadromous Fish Passage and Rearing Habitat



Notched weir in Segment 2

8.1 Introduction

Indicators for anadromous fish passage and rearing habitat are

- depth and velocity,
- vertical barriers, and
- rearing habitat diversity.

The target species for these indicators are steelhead and Chinook salmon.

Data collection, data management, and data analysis and evaluation are discussed for each indicator in later sections of this chapter.

8.1.1 Staff Qualifications

To successfully complete the data collection, data management, and data analysis and evaluation requirements associated with the anadromous fish passage and rearing habitat indicators, the following minimum qualifications for staff members conducting the work are recommended.

8.1.1.1 Data Collection

Data collection should be performed by staff members with a related 4-year college degree (e.g., fish biology or biology) and 2 years professional experience in fish field surveys. Specifically, it is suggested that the staff members have experience with

- use of various fish and fish habitat sampling techniques,
- evaluation of artificial and natural barriers to fish passage,
- interpretation of aerial photographs, and
- use of aerial photographs as a field mapping base.

The data collection methods for most indicators assume that the work will be conducted by a 2-person monitoring team to facilitate safe and efficient data collection. When 2-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

8.1.1.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional GIS experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft SQL relational databases.

8.1.1.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in the design and analysis of biological field studies.

8.2 Depth and Velocity Indicator

The anadromous fish passage and rearing habitat depth and velocity indicator represents the number and location of potential and actual barriers to adult steelhead and Chinook salmon caused by high water velocity and/or shallow water depth. Direct changes to stream channel geometry from the Project may include armored channel sections (e.g., constructed low-flow channel sections), invert stabilization control structures, and weirs (e.g., the weir structure in Segment 2). Indirect changes to stream channel geometry from the Project may include shallow riffles in the natural channel downstream of, or opposite, Project components. In addition, naturally occurring depth and velocity barriers (i.e., non-Project–related) are also identified as part of the monitoring for this indicator because these barriers can impair passage of adult steelhead and Chinook salmon. The purpose of monitoring this indicator is to determine whether changes to stream channel geometry caused by the Project impair passage of adult steelhead and Chinook salmon. Migrating fish must be allowed to access spawning habitat upstream. The measurable objective for the depth and velocity indicator is that water depth within all constructed low-flow channels will exceed 1 foot at flows greater than or equal to 4 cfs and that velocity will be less than 5 fps throughout the Project area during the October–mid-April migration period. Depth and velocity criteria must be met for at least a continuous portion of 10% or 4 feet of the total stream width, whichever is greater (MMP section 4.6.3.1).

8.2.1 Data Collection

8.2.1.1 Permit Requirements

No permits are required for conducting the depth and velocity monitoring described below.

8.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs, printed at a scale of 1 inch = 50 feet (new if first time in field for the monitoring year or from previous depth and velocity barrier monitoring activities if later in the monitoring year);
- depth rod (at least 4 feet long with divisions to 0.1 foot, preferably a top-setting wading rod);
- velocity meter (attached to depth rod and accurate to 0.01 fps);
- 100-foot measuring tape;
- chaining pins and spring clamps (at least 2 of each);
- high-resolution digital camera;
- chest waders and life jackets (for each team member);
- wading staff (for stability and identifying deep water); and
- data collection forms WATER-05 (at least 3 copies), FISH-03A (at least 30 copies), and FISH-03B (at least 3 copies) (appendix D).

8.2.1.3 Schedule

The depth and velocity indicator will be monitored twice a month at 2-week intervals from October–mid-April and within 3 days following major storm events to monitor for barriers resulting from storm debris (chapter 2). A major storm event is defined as instantaneous flows that exceed 500 cfs. Monitoring will occur for 40 years following Project construction.

Depth and velocity data will be collected simultaneously with vertical barrier data. In October, November, and February–April, depth and velocity data will also be collected simultaneously with adult migration and spawning data (chapter 9).

8.2.1.4 Location and Access

Depth and velocity conditions will be monitored at armored channel sections (including constructed low-flow channel sections), invert stabilization control structures, weirs, shallow riffles, and other artificial and natural barriers in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

8.2.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor fish passage conditions based on depth and velocity. These steps are described in detail later in this chapter.

To monitor fish passage conditions based on depth and velocity, the monitoring team will

- monitor stream flows using data posted on the SCVWD web site;
- field measure stream flow at 3 locations;
- identify artificial and natural barriers, including channel constrictions (velocity greater than 5 fps) and shallow riffles (depth less than 1 foot);
- measure stream depth;
- measure stream velocity;
- map potential depth and/or velocity barriers on aerial photographs, printed at a scale of 1 inch = 50 feet;
- photograph potential depth and/or velocity barriers;
- record depth and velocity data on data collection form FISH-03A or FISH-03B;

- assess overall passage conditions at each potential depth and/or velocity barrier; and
- determine whether depth and/or velocity is a barrier to fish passage.

8.2.1.5.1 Mapping and Documentation

In the Office

1. Obtain stream flow data for the area to be monitored from stream gages located in the vicinity. Stream flow data maintained by the SCVWD can be accessed on the Internet at alert.valleywater.org/gagestrm.html.
    - For the Guadalupe River, use the USGS gage on Guadalupe River upstream of the Highway 101 bridge (gage number 11169025).
    - For Guadalupe Creek, use the SCVWD gage downstream of Guadalupe Reservoir (gage number 17).
2. Determine whether stream flow is less than 4 cfs or greater than 35 cfs in the Project area. If stream flow is less than 4 cfs or greater than 35 cfs, do not conduct monitoring. If stream flow is between 4 and 35 cfs, inclusive, record this information on data collection form FISH-03 and continue to the field and conduct monitoring.

    Note: Stream flows at the USGS gage are higher than those in the Project area because of accretions that occur between the Project area and the USGS gage. Therefore, measured flows of 50 cfs or less at the USGS gage usually indicate that flows in the Project area are less than 35 cfs.
3. Review the location of all previously identified potential and actual barriers.

In the Field

4. Begin monitoring at the downstream end of the stream segment to be monitored.
5. Concurrently with steps 6–14, measure stream flow at 3 locations on the Guadalupe River and 1 location on Guadalupe Creek, and record all measurements on data collection form WATER-05. This step is important to generally confirm the gage data reported on the SCVWD web site. For the Guadalupe River, measure stream flow:
    - at Airport Parkway,
    - near Coleman Avenue, and
    - at Woz Way.

For Guadalupe Creek, measure stream flow at Almaden Expressway.

Note: These stream flow measurements are used to supplement USGS and SCVWD gage data.

a. Select an area of uniform flow, such as a run or a pool tailout, but not a pool or riffle. Ideally, the cross section will not have large rocks, logs, or other obstacles, and the depth rod will not sink into soft substrate. Establish a cross section perpendicular to the stream flow in the selected area. The total wetted channel width is included in the cross section.

b. Secure the measuring tape across the width of the channel using the chaining pins.

c. Measure stream depth and flow velocity along the cross section at intervals of 1 foot if the wetted channel width is greater than or equal to 25 feet or at intervals of 6 inches to 1 foot if the wetted channel width is less than 25 feet. There should be at least 25–30 intervals per cross section. If the intervals are not evenly spaced, the greater spacing should occur in the slower-moving water.

   1) Measure the depth, using a depth rod with attached velocity meter, at each interval of the cross section. Depth measurements should be recorded (in feet) to the nearest 0.1 foot on the data collection form.

   2) If depth is less than or equal to 2.5 feet, measure velocity at 0.6 of the stream depth: multiply the depth in inches by 0.6 and hold the meter that many inches from the stream bottom. Use of a top-setting wading rod will allow placement of the velocity sensor at the correct position without needing to calculate the appropriate depth. Follow the manufacturer's directions for operating the velocity meter and the top-setting wading rod. Velocity measurements should be recorded to the nearest 0.1 fps on the data collection form.

   3) If depth is greater than 2.5 feet, measure velocity at 0.2 and 0.8 of the stream depth, and record both velocity measurements on the data collection form.

   Note: The velocity meter instructions should be read to determine whether alternative locations of the velocity readings are suggested for the particular meter being used.

d. Fill out the data collection form. Include comments about water observed to be entering (e.g., through an outfall) or leaving (e.g., through a diversion) the river.

6. Identify potential depth and/or velocity barriers.

   a. Walk upstream in either the stream channel or on the channel bank. If walking in the stream channel, use a wading staff for stability and to identify deep water.

   b. Identify artificial and natural barriers, including channel constrictions (velocity greater than 5 fps) and shallow riffles (depth less than 1 foot).

   c. Map the potential depth and/or velocity barriers on the aerial photographs, and record the potential barrier identification number on the data collection form. Use the following alpha-numeric naming convention to label each potential barrier: water year, 4-letter abbreviation for potential barrier, and a 3-digit consecutive number for each potential barrier, beginning with 001. For example, the first potential barrier for WY 2001 would be labeled 01-BARR-001.

7. If the barrier is

   - a potential depth barrier identified for the first time in a monitoring year, go to step 8;
   - a potential velocity barrier identified for the first time in a monitoring year, go to step 9;
   - both a potential depth barrier and velocity barrier identified for the first time in a monitoring year, complete steps 8–14; or
   - a potential depth or velocity barrier previously identified during the monitoring year, go to step 15.

   Note: When identifying a potential barrier for the first time in a monitoring year, use a separate data collection form (i.e., FISH-03A) for each potential barrier. If a potential barrier is both a depth barrier and a velocity barrier, fill out a single data collection form, considering both depth and velocity criteria together.

8. Measure water depth where depth may be a potential barrier. Record all measurements on data collection form FISH-03A to the nearest 0.1 foot.

   a. Establish a cross section with the measuring tape set perpendicular to the stream flow and across the shallowest portion of the wetted channel. The cross section should span the total width of the wetted channel, with the 0 end of the measuring tape on the right bank.

      Note: Right and left banks are relative to a person facing downstream (Armantrout, 1998).

   b. Record from the measuring tape where the LWE and RWE intersect the cross section, and calculate the wetted channel width to the nearest 0.1 foot.

   c. Measure depth at 2-foot intervals along the cross section, using a depth rod.

      Note: If the cross section is less than 5 feet wide, take only 1 measurement at the deepest point along the cross section, and record the depth and location in "Comments."

d. If depth readings are less than 1 foot at any cross-section interval, determine the upstream and downstream extent of this shallow (i.e., less than 1 foot) depth.

    1) Take periodic depth measurements, perpendicular to the cross section and within the specified cross-section interval, upstream and downstream of the cross section until depth is 1 foot or greater.

    2) Measure the distance between these 2 points, and record this measurement on the data collection form in the column for the appropriate cross-section interval to the nearest 0.1 foot (figure 8-1). For example, if the depth is less than 1 foot in the 8-foot interval and becomes 1 foot or greater at 2 feet upstream and 3 feet downstream of the cross section within this interval, record "5."

Note: It is not necessary to record the periodic depth measurements taken to identify where depth is a minimum of 1 foot on the data collection form.

e. If the potential depth barrier is only a depth barrier, go to step 10. If the potential barrier is also a velocity barrier, go to step 9.

9. Measure water velocity where velocity may be a potential barrier. Record all measurements on data collection form FISH-03A to the nearest 0.1 fps.

a. Establish a cross section with the measuring tape set perpendicular to the stream flow and across the highest velocity portion of the wetted channel. The cross section should span the total width of the wetted channel, with the 0 end of the measuring tape on the right bank.

b. Record from the measuring tape where the LWE and RWE intersect the cross section, and calculate the wetted channel width to the nearest 0.1 foot.

c. Measure velocity, in feet per second, at 2-foot intervals along the cross section (figure 8-2), using a velocity meter.

Note: If the cross section is less than 5 feet, take only 1 measurement at the highest velocity point along the cross section, and record the velocity and location in "Comments."

    1) Measure the depth (in inches) at each cross-section interval using a depth rod with attached velocity meter. Do not record this depth measurement, which is needed only to position the velocity meter at the correct depth in the stream channel, on the data collection form. However, if the potential barrier is both a depth and velocity barrier, depth and velocity measurements can be collected concurrently at this point.

    2) Measure velocity at 0.6 of the stream depth using a velocity meter: multiply the depth [in inches] at the cross-section interval by 0.4 and hold the meter that many inches from the stream channel bottom.

Follow the manufacturer's instructions for operating the velocity meter.

Note: If velocity readings are 5 fps or greater at any cross-section interval, determine the upstream and downstream extent of this high (i.e., 5 fps or greater) velocity.

- Take periodic velocity measurements, perpendicular to the cross section and within the specified cross-section interval, downstream and upstream of the cross section until velocity is less than 5 fps.
- Measure the distance between these 2 points (figure 8-2), and record this measurement on the data collection form in the column for the appropriate cross-section interval to the nearest 0.1 fps.

Note: It is not necessary to record the periodic velocity measurements taken to identify where velocity is less than 5 fps.

10. Photograph each potential depth and/or velocity barrier from both upstream and downstream views, as necessary, to document conditions at the potential barrier under different flows. For potential depth and/or velocity barriers at notched weirs, take 1 additional photograph from the bank looking across the wetted channel on the downstream side of the notched weir. Record the photograph numbers on the data collection form.
11. For a potential depth and/or velocity barrier, determine whether depth and/or velocity criteria are met for each cross-section interval, and fill in the final data row of the data collection form.

    a. For potential depth barriers, determine whether minimum depths are acceptable for each interval along the cross section. Record a "Y" under each interval that meets the minimum depth criteria (i.e., depth greater than 1 foot or depth less than 1 foot extending for less than 6 feet of channel length). Record a "N" under each interval that does not meet the minimum depth criteria (i.e., depth less than 1 foot extending for more than 6 feet of channel length).

    b. For potential velocity barriers, determine whether maximum velocities are acceptable for each interval along the cross section. Record a "Y" under each interval that meets the maximum velocity criteria (i.e., velocity less than 5 fps or velocity equal to or greater than 5 fps extending for less than 6 feet of channel length). Record a "N" under each interval that does not meet maximum velocity criteria (i.e., velocity equal to or greater than 5 fps extending for more than 6 feet of channel length).

    c. For potential depth and velocity barriers, determine whether minimum depths and maximum velocities together are acceptable for each interval along the cross section. Record "Y" under each interval that meets both minimum depth and maximum velocity criteria (i.e., depth equal to or greater than 1 foot or depth less than 1 foot extending for less than 6 feet of channel length and velocity less than 5 fps or velocity equal to or greater than 5 fps extending for less than 6 feet of channel length). Record a "N" under each interval that does not meet both minimum depth and maximum velocity criteria (i.e., depth less than 1 foot extends for more than 6 feet of channel length and/or velocity equal to or greater than 5 fps extends for more than 6 feet of channel length).

12. Determine whether the potential barrier is an actual barrier to fish passage by filling in the Field Calculations Worksheet section at the bottom of the data collection form.

    a. Calculate *A*, *passage corridor width*, using the following calculation: *largest number of continuous intervals where depth and/or velocity criteria are met* x 2. If several continuous intervals are scattered across the stream width, use only the single largest block of continuous intervals.

    b. Calculate *B*, *reference number*, using "4" or the following calculation, whichever is greater: *stream width* x 0.10. For example, the reference number for a 30-foot-wide stream is 4 because 10% of 30 is 3.

    c. Determine whether *A* is greater than *B*.

        1) If *A* is greater than *B*, the potential barrier is not a barrier.

        2) If *A* is less than *B*, the potential barrier is a barrier. Indicate the type of barrier. If a velocity barrier is indicated *and* the potential barrier is a notched weir, conduct a vertical barrier assessment.

    Note: A special case exists when determining whether potential velocity barriers are actual barriers if the potential velocity barrier is a notched weir. If a notched weir is a potential velocity barrier, vertical barrier criteria should also be applied to the notched weir (section 8.3.1.5.1). The application of the vertical barrier criteria is appropriate because fish may be able to pass a notched weir velocity barrier if flows are such that they can leap over the wing walls of the weir and avoid the high-velocity area at the notch opening.

13. At each potential depth and/or velocity barrier, assess overall passage conditions using professional judgement, and document conclusions on the data collection form.

    Note: Professional judgment of overall passage conditions is included to determine whether circumstances, not indicated by the measurements, are present that might allow/prevent fish passage.

14. Sketch a diagram (plan view) of the potential barrier on the data collection form, showing relative locations of depth and/or velocity measurements.

15. If the potential barrier is a barrier previously identified during the monitoring year, perform a visual assessment of passage conditions to determine whether the site continues to be a fish passage barrier. Record the potential barrier's identification number, a description of the potential barrier, the field measured flow and time at which the flow data were collected, and whether the potential barrier is an actual depth barrier, an actual velocity barrier (if it is both an actual depth and velocity barrier, check both the depth and velocity boxes), or not an actual barrier on data collection form FISH-03B.

16. Photograph each previously identified potential depth and/or velocity barrier from both upstream and downstream views, as necessary, to document conditions at the potential barrier under different flows. For potential depth and/or velocity barriers at notched weirs, take 1 additional photograph from the bank looking across the wetted channel on the downstream side of the notched weir. Record the photograph numbers on the data collection form.

In the Office

17. Download digital images from the digital camera for filing in GEMS.

18. Calculate stream flow from field-measured flow data and enter flow on the data collection form. Methods for calculating flow are described in section 6.2.4.7.

    - For potential barriers in Reach A or Segment 1, use stream flow data measured at Airport Parkway.
    - For potential barriers in Segments 2 or 3A and Segment 3B upstream to the Los Gatos Creek confluence, use stream flow data measured in Segment 2 downstream of Coleman Avenue.
    - For potential barriers in Segment 3B upstream of the Los Gatos Creek confluence, the Woz Way to Park Avenue Bypass, and Segment 3C, use stream flow data measured in Segment 3C at Woz Way.
    - For potential barriers in Guadalupe Creek, use streamflow data measured at Almaden Expressway.

8.2.1.5.2 Immediate Remedial Actions Required

If depth and/or velocity barriers caused by temporary storm debris are identified, the Corps and SCVWD will be immediately notified by both telephone and either facsimile or email at the conclusion of the monitoring activity. The MMP requires that depth and velocity barriers caused by debris dams or other temporary blockage be removed within 3 working days from notification. Depth and/or velocity barriers resulting from Project components are not subject to the 3-working-day remedial action requirement and will be addressed on a case-by-case basis, with input from the Adaptive Management Team.

8.2.2 Data Management

Depth and velocity data will be collected twice a month at 2-week intervals from October–mid-April to and within 3 days following major storm events for 40 years following Project construction (MYs 1–40). Depth and velocity data are recorded on the FISH-03 data collection form, along with a field-sketched diagram of each barrier. Each identified potential barrier is visually reassessed during subsequent monitoring activities conducted within that monitoring year. Depth and velocity data will be stored in GEMS: data collected with data collection form FISH-03 or WATER-05 will be entered in the RDBMS and data collected on aerial photographs will be entered in the GIS database. The field-sketched diagrams of barriers will be scanned at a resolution of 150 dots per inch and saved in a compressed format (JPG or TIFF). The resulting digital image file should be named and stored in GEMS ground-level digital image library using the naming conventions described in section 3.4.2.6.1.

Note: Data collected on data collection forms FISH-03A and FISH-03B will be entered into the same data entry form in the RDBMS.

8.2.2.1 Data Structure

The following primary data tables (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the depth and velocity indicator.

8.2.2.1.1 Tables for Data Collection Forms FISH-03A and FISH-03B

For data collection forms FISH-03A and FISH-03B, the following tables are used:

- tblDepthandVelocity (primary data table),
- tblStreamSegment,
- tblStreamGage,
- tblStream,
- tblDVMeasurements,
- tblDVTeam, and
- tblMembers.

Figure B-22 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

8.2.2.1.2 Tables for Data Collection Form WATER-05

For data collection form WATER-05, the following tables are used:

- tblStreamFlowMeasurements (primary data table),
- tblSFMData,
- tblStreamSegment,
- tblJSATempModel,
- tblSFMTeam, and
- tblMembers.

Figure B-17 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

8.2.2.2 Data Entry

Data from the FISH-03 and WATER-05 data collection forms will be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

8.2.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following data quality assurance check is performed during data entry by the RDBMS software.

8.2.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry.

8.2.2.3.1.1 Lookup Values for Data Collection Form FISH-03

There are 2 lookup values for data collection form FISH-03:

- stream segment and
- gage number.

8.2.2.3.1.2 Lookup Values for Data Collection Form WATER-05

There are 3 lookup values for data collection form WATER-05:

- stream segment,
- model segment, and
- location within the model segment (U, D, or G for upstream end, downstream end, or at the gage).

8.2.2.3.2 Data Structure and Entry for Aerial Photographs

Locations where depth and velocity barrier data are collected are recorded as lines on aerial photographs. Aerial photographs annotated in the field with potential and actual depth and velocity barrier locations will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized lines will be attributed with potential barrier identification numbers. All lines for a given monitoring year will be included in 1 shapefile named “Anadromous_Fish_Passage_and_Rearing_Habitat_Barriers_yy,” where “yy” is year (e.g., “01”). This shapefile will also include potential vertical barrier and rearing habitat diversity data.

8.2.3 Data Analysis and Evaluation

The analysis and evaluation of the depth and velocity monitoring data assesses whether water depth and velocity meet the measurable objective of adequate upstream migration of adult steelhead and Chinook salmon when flow is between 4 and 35 cfs, inclusive. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

8.2.3.1 Calculations

The assessment of whether the potential barrier is an actual barrier is performed in the field.

Stream flow (cubic feet per second) is calculated using the field-measured data (i.e., width, depth, and velocity measurements at the cross sections). Calculations are necessary to determine stream flow for cross sections at Airport Parkway, near Coleman Avenue, at Woz Way, and near Almaden Expressway based on field measurements recorded on data collection form WATER-05. The methods for calculating stream flow are described in section 6.2.4.7.

8.2.3.2 Statistical Analysis Methods

No statistical analysis is necessary.

8.2.3.3 Comparison to Measurable Objective

Provide a description of each barrier, including the type of barrier, relative to velocity or depth. Discuss remedial actions taken or proposed as well as recommendations for future monitoring.

8.3 Vertical Barrier Indicator

The anadromous fish passage and rearing habitat vertical barrier indicator represents the number and location of potential and actual barriers to adult steelhead and Chinook salmon caused by vertical height in all Project locations where the stream channel has been modified by armoring, construction of a low-flow channel, and/or construction of invert stabilization control structures. Vertical barriers may occur at constructed components or natural features. Constructed components include armored channel sections (e.g., constructed low-flow channel sections), invert stabilization control structures, stream gages, and weirs. Natural barriers include debris dams and vertical drops in elevation caused by down cutting of the stream bed. Natural barriers are formed by the action of the river, but Project components may create conditions that cause natural barrier formation. The purpose of monitoring this indicator is to determine whether movement of adult steelhead and Chinook salmon is impaired by Project-related effects. Migrating fish must be allowed to access spawning habitat upstream of potential barriers. The measurable objective for the vertical barrier indicator is that vertical barriers must allow for adequate upstream migration of adult steelhead and Chinook salmon when flow is greater than or equal to 4 cfs in October–mid-April. Fish passage is considered to be blocked when the ratio of staging pool to barrier height is less than 1.25 or the height and length dimensions exceed the leaping abilities of steelhead or Chinook salmon (MMP section 4.6.3.2).

8.3.1 Data Collection

8.3.1.1 Permit Requirements

No permits are required for conducting the vertical barrier monitoring described below.

8.3.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs, printed at a scale of 1 inch = 50 feet (new if first time in field for the monitoring year or from previous vertical barrier monitoring activities if later in the monitoring year);
- depth rod (at least 4 feet long with divisions to 0.1 foot, preferably a top-setting wading rod);
- 100-foot measuring tape;
- chaining pins and spring clamps (at least 2 of each);
- high-resolution digital camera;
- chest waders and life jackets (for each team member);
- wading staff (for stability and identifying deep water); and
- data collection form FISH-04 (at least 30 copies; appendix D).

8.3.1.3 Schedule

The vertical barrier indicator will be monitored twice a month at 2-week intervals from October–mid-April and within 3 days following major storm events to monitor for barriers resulting from storm debris (chapter 2). A major storm event is defined as instantaneous flows that exceed 500 cfs. Monitoring will occur for 40 years following Project construction.

Vertical barrier data will be gathered simultaneously with depth and velocity data. In October, November, and February–April, vertical barrier data will also be collected simultaneously with adult migration and spawning data (chapter 9).

8.3.1.4 Location and Access

Vertical barrier conditions will be monitored in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

8.3.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor fish passage conditions related to vertical barriers. These steps are described in detail later in this chapter.

To monitor fish passage conditions related to vertical barriers, the monitoring team will

- monitor stream flows using data posted on the SCVWD web site;
- identify potential vertical barriers (where vertical height of drop is greater than 0.5 foot);

- map potential vertical barriers on aerial photographs, printed at a scale of 1 inch = 50 feet;
- measure height of potential barrier;
- measure the horizontal distance fish must jump to clear barrier;
- measure staging pool depth;
- record vertical barrier data on data collection form FISH-04;
- determine whether the vertical rise is a barrier to fish passage; and
- photograph potential vertical barriers.

8.3.1.5.1 Mapping and Documentation

In the Office

1. Obtain stream flow data for the area to be monitored from stream gages located in the vicinity. Stream flow data maintained by the SCVWD can be accessed on the Internet at alert.valleywater.org/gagestrm.html.

    - For the Guadalupe River, use the USGS gage on Guadalupe River upstream of the Highway 101 bridge (gage number 11169025).
    - For Guadalupe Creek, use the SCVWD gage downstream of the Guadalupe Reservoir (gage number 17).

2. Determine whether stream flow is less than 4 cfs or greater than 35 cfs in the Project area. If stream flow is less than 4 cfs or greater than 35 cfs, do not conduct monitoring. If stream flow is between 4 and 35 cfs, inclusive, record this information on data collection form FISH-04 and continue to the field and conduct monitoring.

    Note: Stream flows at the USGS gage are higher than those in the Project area because of accretions that occur between the Project area and the USGS gage. Therefore, measured flows of 50 cfs or less at the USGS gage usually indicate that flows in the Project area are less than 35 cfs.

3. Review the location of all previously identified potential and actual barriers.

In the Field

4. Begin monitoring at the downstream end of the stream segment to be monitored.

    Note: For potential barriers previously identified within a single monitoring year, it is not necessary to take physical measurements of water depths and velocities. Rather, a visual assessment of passage conditions can be performed to determine whether or not the site *continues to be a fish passage barrier. Record this information in "Visual Assessment" and in "Comments."*

5. Identify potential vertical barriers.

   a. Record the start point of the monitoring on the data collection form. (Multiple potential barriers will be recorded on the same data collection form. When the form is full, record the end point of the monitoring collected on that form, and begin a new form.)

   b. Walk upstream in either the stream channel or on the channel bank. If walking in the stream channel, use a wading staff for stability and to identify deep water.

   c. Identify areas where the vertical height of a drop is greater than 0.5 foot.

   Note: Vertical heights of 3.0 feet or greater are considered a barrier to fish passage regardless of the values of other parameters. Vertical heights of less than 0.5 foot are not considered to be passage barriers to migrating salmonids. Structures having vertical heights of intermediate distance (0.5–3.0 feet) are potential vertical barriers, depending on the values of other measured parameters (e.g., staging pool depth and horizontal jumping distance).

   d. Map the location of the potential vertical barrier on the aerial photograph, and record the potential vertical barrier identification number on the data collection form. Use the following alpha-numeric naming convention to label each potential barrier: water year, 4-letter abbreviation for potential vertical barrier, and a 3-digit consecutive number for each potential barrier, beginning with 001. For example, the first potential vertical barrier for WY 2001 would be labeled 01-BARR-001.

6. Measure the height, staging pool depth, and horizontal jumping distance of the potential vertical barrier (figure 8-3). Record all measurements on the data collection form to the nearest 0.1 foot.

   a. Measure the height of the potential vertical barrier. On the downstream side of the potential vertical barrier, measure the vertical distance from the water surface to the highest point of the barrier. For notched weirs, measure the vertical distance from the water surface to the bottom of the notch.

   b. Measure the depth of the staging pool at the point where the water plunges into the pool, using the depth rod.

   c. Use the depth rod to locate the landing point (i.e., the point in the landing pool where depth first reaches 1 foot on the upstream side of the barrier).

   d. Determine the horizontal jumping distance (i.e., the distance upstream from the point where water plunges into the staging pool to the landing point upstream of the barrier [the points measured in steps b and c above]).

7. Determine whether the potential vertical barrier is a barrier to fish passage. The potential barrier is a barrier to fish passage if

   - barrier is more than 3.0 feet high,
   - horizontal jumping distance is greater than 5.4 feet, OR
   - staging pool depth is less than 1.25 times the height of the potential barrier.

8. Photograph each potential vertical barrier from upstream, downstream, and side views. Record the photograph numbers on the data collection form.
9. Assess overall passage conditions using professional judgement, and document comments on the data collection form.

   Note: Professional judgment of overall passage conditions is included to determine whether circumstances, not indicated by the measurements, are present that might allow/prevent fish passage.

In the Office

10. Download digital images from the digital camera for filing in GEMS.

8.3.1.5.2 Immediate Remedial Actions Required

If vertical barriers are identified, the Corps and SCVWD will be immediately notified by both telephone and either facsimile or email at the conclusion of the monitoring activity. The MMP requires that vertical barriers caused by debris dams or other temporary blockage be removed within 3 working days from notification. Vertical barriers resulting from Project structures are not subject to the 3-working-day remedial action requirement and will be addressed on a case-by-case basis, with input from the Adaptive Management Team.

8.3.2 Data Management

Vertical barrier data will be collected twice a month at 2-week intervals from October–mid-April and within 3 days after base flow conditions have returned following major storm events for 40 years following Project construction (MYs 1–40). Vertical barrier data are recorded on data collection form FISH-04. Each identified potential barrier is visually reassessed during subsequent monitoring activities conducted within that monitoring year. All anadromous fish passage and rearing habitat vertical barrier data will be stored in GEMS: data collected with data collection form FISH-04 will be entered in the RDBMS, and data collected on aerial photographs will be entered in the GIS database.

8.3.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the vertical barrier indicator:

- tblVerticalBarrier (primary data table),
- tblStreamSegment,
- tblStartPoint,
- tblEndPoint,
- tblStreamGage,
- tblStream,
- tblVBData,
- tblVBTeam, and
- tblMembers.

Figure B-23 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

8.3.2.2 Data Entry

Data from the FISH-04 data collection forms will being to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

8.3.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

8.3.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream segment and
- stream gage number.

8.3.2.4 Data Structure and Entry for Aerial Photographs

Locations where vertical barrier data are collected are recorded as lines on aerial photographs. Aerial photographs annotated in the field with vertical barrier locations will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized lines will be attributed with potential barrier identification numbers. All lines for a given monitoring year will be included in 1 shapefile named "Anadromous_Fish_ Passage_and_Rearing_Habitat_Barriers_yy," where "yy" is year (e.g., "01"). The shapefile will also include potential depth and velocity barrier and rearing habitat diversity data.

8.3.3 Data Analysis and Evaluation

The analysis and evaluation of the vertical barrier monitoring data assesses whether the measurable objective of adequate upstream passage conditions for migration of adult steelhead and Chinook salmon is met when flow is between 4 and 35 cfs, inclusive. In addition, an analysis and evaluation may be needed to determine what remedial actions should be recommended if the measurable objective is not met.

8.3.3.1 Calculations

No postfield calculations are necessary. The assessment of whether the potential barrier is an actual barrier is performed in the field.

8.3.3.2 Statistical Analysis Methods

No statistical analysis is necessary.

8.3.3.3 Comparison to Measurable Objective

Provide a description of each potential vertical barrier, including the type of vertical barrier (e.g., weir [indicate type], hardscape/natural channel bottom transition area, headcut, or debris dam) and the cause of the vertical barrier in the context of the Project (i.e., direct, indirect, or no effect). Discuss remedial actions taken or proposed and recommendations for future monitoring.

8.4 Rearing Habitat Diversity Indicator

The anadromous fish passage and rearing habitat rearing habitat diversity indicator represents the frequency of occurrence and the size of riffles, runs, and pools in the Project area. The purpose of monitoring this indicator is to determine whether the Project has reduced the diversity of habitat types available to juvenile steelhead and Chinook salmon. A diversity of habitat types provides spawning, resting, and feeding areas for fish. Riffles provide important fish-spawning habitat and food-producing areas, pools provide cover and moderate variability in water temperature, and runs provide habitat values intermediate between those of riffles and pools.

The measurable objective for the rearing habitat diversity indicator in Segments 1, 2, 3A, 3B, and 3C and the Woz Way to Park Avenue Bypass is that the occurrence and average length of habitat types will be at least within 10% of preproject values for any habitat type (MMP section 4.6.3.3). Because preproject data were not available at the resolution necessary for Segments 1, 2, 3A, 3B, and 3C and the Woz Way to Park Avenue Bypass, postproject data collected in WY 2001 are used in place of preproject data.

The measurable objective for the rearing habitat diversity indicator in Reach A and Guadalupe Creek is an occurrence and average length of riffles and runs within 10% of the rearing habitat diversity measured in WY 2001 for Reach A and WY 2002 for Guadalupe Creek. In addition, the proportion of stream length comprising pools in Reach A and Guadalupe Creek must be within 10% of the optimal range for salmonids (i.e., 36–71%).

8.4.1 Data Collection

8.4.1.1 Permit Requirements

No permits are required for conducting the rearing habitat diversity monitoring described below.

8.4.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs of Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek, printed at a scale of 1 inch = 50 feet (for mapping habitat types);
- 100-foot measuring tape;
- high-resolution digital camera;
- chest waders and life jackets (for each team member);
- float tube, pump, patch kit, and fins for deep pools;
- stadia rod or other instrument for measuring stream depth;
- wading staff (for stability and identifying deep water);
- data collection form FISH-05 (at least 1 form per day; appendix D); and

- worksheets FISH-05A and FISH-05B (at least 1 form per day; appendix D).

8.4.1.3 Schedule

The rearing habitat diversity indicator will be monitored once a year between June and September when stream flows are at the average summer low flow (chapter 2). Preproject monitoring will occur only in Reach A; Segments 3A and 3B; and Guadalupe Creek. Postproject monitoring will occur during the first 5 years following Project construction (MYs 1–5).

Note: Data for the rearing habitat diversity indicator must be collected before monitoring of the instream cover and juvenile rearing indicators can occur.

8.4.1.4 Location and Access

Rearing habitat diversity will be monitored in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Access to these areas requires coordination with the SCVWD.

8.4.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor rearing habitat diversity. These steps are described in detail later in this chapter.

To monitor rearing habitat diversity, the monitoring team will

- measure the frequency and dimensions of 3 general habitat types: riffles, runs, and pools;
- visually assess habitat quality and provide numerical ranking, using worksheets FISH-05A or FISH-05B;
- map habitat types on aerial photographs, printed at a scale of 1 inch = 50 feet;
- photograph habitat types representing different numerical rankings for habitat quality; and
- record rearing habitat diversity data on data collection form FISH-05.

8.4.1.5.1 Mapping and Documentation

In the Field

1. Begin monitoring at the downstream end of the stream segment to be monitored.
   - For the Guadalupe River, the start point is the Airport Parkway bridge at the downstream end of Reach A, and the end point is Grant Street near the upstream end of Segment 3.
   - For Guadalupe Creek, the start point is the Almaden Expressway bridge, and the end point is Masson Dam.
2. Walk upstream in the stream channel. Use a float tube to traverse deep water and to assist in measuring habitat dimensions.
3. Locate riffles, runs, and pools.
4. Map the location of each riffle, run, and pool on the aerial photograph by marking the upstream and downstream extent of the habitat.

   Note: Every part of the river will fit into 1 of the habitat types (i.e., no part of the river should be left unmapped or mapped as "other").
5. Measure the width and depth, at the widest and deepest points, respectively, of each riffle, run, and pool, to the nearest 0.1 foot.
6. Record the stream segment in which each habitat type occurs on data collection form FISH-05. The stream segment for each habitat type should be the stream segment in which the habitat type starts (i.e., if a habitat type spans stream segments, the entire habitat type should be assigned to the most downstream segment).
7. Record the habitat type and measurements on data collection form FISH-05. Use the following alpha-numeric naming convention to label each habitat unit: water year, 4-letter abbreviation for habitat unit (i.e., RIFF, RUNN, POOL), and a 3-digit consecutive number for each habitat unit, beginning with 001. For example, if the first 5 habitats encountered in WY 2001 were a riffle, a run, a riffle, a run, and a pool, they would be designated 01-RIFF-001, 01-RUNN-002, 01-RIFF-003, 01-RUNN-004, and 01-POOL-005.
8. Visually assess habitat quality of each habitat type relative to the rearing needs of steelhead and Chinook salmon, using either the riffle/run worksheet (FISH-05A) or the pool worksheet (FISH-05B).

   a. For riffle and run habitat types, assess the quality of each habitat component shown on the worksheet: embeddedness, instream cover (e.g., undercut banks, boulders, instream woody material, and vegetation), canopy coverage, and bank composition.

      1) Using table 8-1, which is also reproduced on the worksheet, assign a numeric score to each habitat component.

2) Sum the scores for all the habitat components.

3) Record the total score on both the worksheet and the data collection form.

Table 8-1. Numeric Scores Used for Riffle/Run Habitat Types

Score		Habitat Component				
					Bank Composition[a, b]	
Numeric	Narrative	Embeddedness[a] (% fines)	Cover[b] (%) (instream cover; substrate [10–40cm])	Canopy Coverage[a] (%) (stream area shaded between 1000 and 1400 hours)	Rooted Vegetation and Stable Rocky Ground Cover along Bank (%)	Bank Slope (%) and Condition
1	Good	≤ 10	≥ 10	≥ 50	≥ 75	< 30; not actively eroding
2	Fair	11–45	4–9	10–49	26–74	30–60
3	Poor	> 45	< 4	< 10	≤ 25	> 60; actively eroding

[a] Source: U.S. Fish and Wildlife Service, 1984. *Habitat Suitability Information: Rainbow Trout*. FWS/OBS-82/10.60. Embeddedness = V_{16}; Cover = V_8; Canopy = V_{17}; Bank Composition = V_{12}.

[b] Source: Pfankuch, 1975. *Channel Stability Evaluation.*

b. For pool habitat types, measure the riffle crest depth (i.e., the deepest point in the shallowest continuous line perpendicular to the riffle) and the maximum pool depth. Assess the quality of each habitat component shown on the worksheet: residual pool depth, cover, canopy, and bank composition (table 8-2).

1) Using table 8-2, which is also reproduced on the worksheet, assign a numeric score to each habitat component.

2) Sum the scores for all the habitat components.

3) Record the total score on both the worksheet and the data collection form.

9. Photograph at least 4 examples of habitat types representing each numerical rank during the first monitoring year to ensure consistency of ranking between monitoring team members and monitoring years.

Table 8-2. Numeric Scores Used for Pool Habitat Types

Score		Habitat Component					
			Instream Cover[a]		Canopy Coverage[a] (%) (stream area shaded between 1000 and 1400 hours)	Bank Composition[a, b]	
Numeric	Narrative	Residual Pool Depth[c] (feet)	Instream Cover (logs, debris piles, boulders, overhanging banks, and vegetation) (%)	Number of Types		Rooted Vegetation and Stable Rocky Ground Cover along Bank (%)	Bank Slope (%) and Condition
1	Good	> 4.9	> 30	$3	> 50	≥ 75	< 30; not actively eroding
2	Fair	1– 4.8	5– 30	1–3	10–49	26–74	30–60
3	Poor	<1	< 5	0–1	< 10	≤ 25	> 60; actively eroding

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[a] Source: U.S. Fish and Wildlife Service. 1984. *Habitat Suitability Information: Rainbow Trout.* FWS/OBS-82/10.60. Residual Pool Depth = V_{15}; Cover = V_{15}; Canopy = V_{17}; Bank Composition = V_{12}.

[b] Source: Pfankuch, 1975. *Channel Stability Evaluation*.

[c] Residual pool depth is the maximum pool depth minus the water depth at the deepest point along the riffle crest at the downstream end of the pool.

In the Office

10. Download digital images from the digital camera for filing in GEMS.

8.4.1.6 Immediate Remedial Actions Required

No immediate remedial actions are required for the rearing habitat diversity indicator.

8.4.2 Data Management

Rearing habitat diversity will be collected once a year between June and September for 5 years following Project construction (MYs 1–5) and every fifth year thereafter through MY 40 (MYs 10, 15, 20, 25, 30, 35, and 40). Rearing habitat diversity data are recorded on data collection form FISH-05 (data from worksheets FISH-05A and FISH-05B are transferred onto data collection form FISH-05 and not entered directly into GEMS). This indicator is recorded for each riffle, run, and pool. Rearing habitat diversity data are stored in the RDBMS of GEMS.

8.4.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the rearing habitat diversity indicator:

- tblRearingHabitatDiv (primary data table),
- tblStream,
- tblStartPoint,
- tblEndPoint,
- tblStreamSegment,
- tblHabitatType,
- tblHabitatQRank,
- tblRHDPhoto,
- tblRHDTeam, and
- tblMembers.

Figure B-24 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

8.4.2.2 Data Entry

Data from the FISH-05 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

8.4.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

8.4.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream segment,
- habitat type, and
- habitat quality ranking.

8.4.2.4 Data Structure and Entry for Aerial Photographs

Rearing habitat diversity locations are recorded as lines on aerial photographs. Aerial photographs annotated in the field with rearing habitat diversity locations will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized lines will be attributed with rearing habitat diversity identification numbers. All polygons for a given monitoring year will be included in 1 shapefile named "Anadromous_ Fish_Rearing_Habitat_Diversity_mmmyy," where "mmm" is month (e.g., "jan") and "yy" is year (e.g., "01"). This shapefile will also include potential depth and velocity and vertical barrier data.

Using GIS query capabilities, the GIS analyst will calculate the length of each individual habitat type unit. The length data will be input into the rearing habitat diversity data entry form in the RDBMS.

8.4.3 Data Analysis and Evaluation

The analysis and evaluation of the rearing habitat diversity data assesses whether the measurable objective of occurrence and average length of postproject habitat types for Segments 1, 2, 3A, 3B, and 3C and the Woz Way to Park Avenue Bypass is within at least 10% of preproject conditions. Because preproject data were not available at the resolution necessary for Segments 1, 2, 3A, 3B, and 3C and the Woz Way to Park Avenue Bypass, postproject data collected in WY 2001 are used in place of preproject data. The measurable objective for Reach A and Guadalupe Creek is an occurrence and average length of riffles and runs within 10% of the rearing habitat diversity measured in WY 2001 for Reach A and WY 2002 for Guadalupe Creek. In addition, the proportion of stream length comprising pools in Reach A and Guadalupe Creek must be within 10% of the range considered optimal for salmonids (i.e., 36–71%).

8.4.3.1 Calculations

Calculate the following variables for Reach A; Segments 1, 2, and 3; Woz Way to Park Avenue Bypass; Guadalupe Creek, and all stream segments combined:

- *total number of riffles, runs, and pools;*
- *average length of riffles, runs, and pools;*
- *standard deviation of the average length of riffles, runs, and pools;* and
- *total length of riffles, runs, and pools.*

8.4.3.2 Statistical Analysis Methods

Prepare the following bar graphs:

- *number of occurrences of each habitat type* versus *monitoring year* and
- *average length of each habitat type* versus *monitoring year.*

8.4.3.3 Quality Assurance

Verify the basic level of accuracy of the data by checking the following.

- **Large changes in number of habitat types or average length of each habitat type between monitoring years.** Compare the number and average length of each habitat type between monitoring years (e.g., by tabulating the difference between years), and determine whether unexpected changes occurred that cannot be easily explained by large storm events or Project effects. If unexplained values are found, check data collection form FISH-05 and worksheets-05A and 05B for entry and calculation errors, the aerial photographs for mapping errors, and the GIS database for digitizing errors. If necessary, examine the stream segment in the field, and determine whether the habitat length values are correct. Correct GEMS, as appropriate.

8.4.3.4 Comparison to Measurable Objective

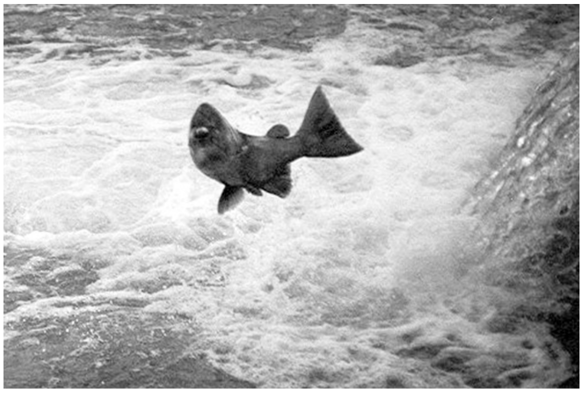
Compare the number and average length of each habitat type for all stream segments (i.e., Reach A; Segments 1, 2, and 3; Woz Way to Park Avenue Bypass; and Guadalupe Creek) to the initial postproject condition. Identify changes in occurrence or average length of more than 10% that have occurred over the previous 3–5 years, and discuss the cause of change.

Recommendations for remedial actions are based on a change in habitat diversity (i.e., greater than 10%) that clearly reflects a change in spawning, resting, and feeding areas for steelhead and Chinook salmon. If the measurable objective is not achieved for the rearing habitat diversity indicator, remedial actions may include development of alternative measures of rearing habitat diversity or measures to replace lost spawning and rearing habitat.

A change in number and length of riffles and runs is compared to the change in spawning habitat area calculated for the spawning gravel abundance indicator. The locations of riffles and runs could also be compared to the location of observed spawning, as represented by the adult migration and spawning indicator. For rearing, the juvenile rearing indicator may provide information on the importance of runs, riffles, and pools as rearing habitat. Changes in rearing habitat diversity will be evaluated in the context of the relative importance of each habitat type to juvenile steelhead, as indicated by variation in density. If the number or length of riffles and runs does not appear to be related to spawning habitat abundance, alternative measures of habitat diversity will be recommended (e.g., separation of pool tails from the measurement of pools). Similarly, if juvenile steelhead density is unrelated to the habitat types included in the diversity indicator, alternative measures of habitat diversity may be recommended.

If the number or length of riffle and runs is related to spawning habitat abundance or if juvenile steelhead density is related to the habitat types included in the diversity indicator, change in the rearing habitat diversity indicator should be evaluated. If the change in rearing habitat diversity, based on documented relationships to spawning and rearing habitat, indicates loss of habitat area, measures to replace or minimize the loss of spawning and rearing habitat will be recommended. The recommendation will take into consideration environmental information from related indicators (i.e., spawning habitat abundance and juvenile rearing). After MY 5, the data will be used to determine future monitoring needs.

Chapter 9
Anadromous Fish Occurrence



Chinook salmon attempting to leap the St. John Street weir

9.1 Introduction

Indicators for anadromous fish occurrence are

- adult migration and spawning and
- juvenile rearing.

The target species for the adult migration and spawning indicator are steelhead and Chinook salmon, and the target species for the juvenile rearing indicator is steelhead. Fish occurrence and abundance reflect the cumulative influence of environmental conditions that are both dependent and independent of Project effects. Therefore, the anadromous fish occurrence indicators do not, and are not intended to, indicate species response solely to the Project effects.

Monitoring the anadromous fish occurrence indicators will improve documentation of steelhead and Chinook salmon occurrence in the Guadalupe River system and passage through the Project area. The anadromous fish occurrence indicators will provide information that may be used by the Adaptive Management Team to assess the need for changes in monitoring methods or the need for additional habitat indicators that more appropriately match observed life stage timing and habitat use by steelhead and Chinook salmon.

Data collection, data management, and data analysis and evaluation are discussed for each indicator in later sections of this chapter.

9.1.1 Staff Qualifications

To successfully complete data collection, data management, and data analysis and evaluation requirements associated with the anadromous fish occurrence indicators, the following minimum qualifications for staff conducting the work are recommended.

9.1.1.1 Data Collection

Data collection should be performed by staff members with a related 4-year college degree (e.g., fish biology or biology) and 2 years professional experience in fish field surveys. Specifically, it is suggested that the staff members have experience with

- use of various fish and fish habitat sampling techniques,
- visual identification of salmonid redds,
- interpretation of aerial photographs, and
- use of aerial photographs as a field mapping base.

The data collection methods for most indicators assume that the work will be conducted by a 2- to 6-person monitoring team to facilitate safe and efficient data collection. When 2- to 6-person monitoring teams are being used, it may be appropriate that only 1 team member has the minimum qualifications recommended above.

9.1.1.2 Data Management

Data management includes data entry, GIS data management, and database development and administration. Data entry should be performed by data collection staff members and/or data entry technicians. Although data entry can be done solely by data entry technicians, the involvement of data collection staff adds quality assurance.

GIS data management should be performed by a staff member(s) with a related 4-year college degree (e.g., geography or GIS) and 2 years professional experience using ARC/INFO, including digitizing, editing, and plotting. The GIS data management staff member will also be responsible for ordering, acceptance checking, and importing digital aerial photography; therefore, experience with aerial photography or remote sensing is also suggested.

Database administration should be performed by a staff member(s) with a related 4-year college degree (e.g., computer science) and 2 years professional experience in database development and administration of Microsoft SQL relational databases.

9.1.1.3 Data Analysis and Evaluation

Data analysis and evaluation should be performed by a staff member(s) with a related 4-year college degree (e.g., biology with advanced coursework in statistics) and 2 years professional experience in the design and analysis of biological field studies.

9.2 Adult Migration and Spawning Indicator

The anadromous fish occurrence adult migration and spawning indicator represents the occurrence and spawning of adult steelhead and Chinook salmon in the Project area. The purpose of monitoring this indicator is to provide information on the adequacy of fish passage and aid in the identification of potential critical stream reaches. The presence or absence of adult steelhead and Chinook salmon and redd location data will improve estimates for the timing of migration and spawning. The monitoring may also provide observation of delay or movement through Project stream segments, indicating the adequacy or inadequacy of anadromous fish passage indicators for assessment of Project effects, including depth and velocity and vertical barriers (chapter 8).

The measurable objective for the adult migration and spawning indicator is that the Guadalupe River must continue to support migration and spawning of adult steelhead and Chinook salmon at a level that is consistent with preproject conditions and environmental conditions not affected by the Project (MMP section 4.7.3.1). The adult migration and spawning indicator also includes subobjectives that confirm

- adult migration and spawning occur at water temperatures consistent with the measurable objectives for the monthly thermal suitability and short-term thermal suitability indicators,
- adult migration through the Project area is consistent with conclusions based on evaluation of measurable objectives for the depth and velocity and vertical barrier indicators, and
- spawning occurs in gravel that is included in the measurable objective for the spawning gravel abundance indicator.

9.2.1 Data Collection

9.2.1.1 Permit and Special Reporting Requirements

A supplemental biological opinion (BO) (dated October 28, 2003) under Section 7 of the ESA has been issued for the Project by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) (McInnis pers. comm.) (appendix I). All associated requirements from the supplemental BO that apply to the monitoring of the adult migration and spawning indicator have been incorporated into the methodology that follows in this section.

Special reporting requirements have been identified in the supplemental BO beyond those described in chapter 10 for the adult migration and spawning indictor. These requirements include 1) reporting all observations of steelhead that occur during monitoring of the adult migration and spawning indicator within 1 week of the observation and 2) providing a preliminary report of the results of monitoring of the adult migration and spawning indicator within 5 months of the last monitoring date. All reporting should be directed to the Protected Resources Division Supervisor, NOAA Fisheries, Santa Rosa Area Office, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404; telephone number 707/575-6050; facsimile number 707/578-3435.

9.2.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs (preferably laminated), printed at a scale of 1 inch = 50 feet (new if first time in field for the monitoring year or from previous adult migration and spawning monitoring activities if later in the monitoring year);

  Note: Aerial photographs should include Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek; and areas upstream of the Project area known to support spawning. These areas include the Upper Guadalupe River (i.e., in the vicinity of Foxworthy Avenue and from Branham Lane to the Alamitos drop structure), Los Gatos Creek (i.e., from Lincoln Avenue to Bascom Avenue), upper Guadalupe Creek (i.e., from Masson Dam to the confluence with Shannon Creek), and Alamitos Creek (i.e., from Almaden Lake to the Calero Creek confluence). If aerial photograph coverage is unavailable for areas upstream of the Project area, use GPS to document fish occurrence in those areas.

- flow meter and wading rod;
- coded-wire-tag recovery forms (waterproof);
- 100-foot measuring tape;
- plastic freezer bags (sealable, 1 gallon size);
- hand-held thermometer (°F) (for measuring water temperature);
- polarized sunglasses (to reduce glare coming off the water);
- knife or machete;
- Secchi tube;

- GPS receiver with 1-meter accuracy (for use in areas upstream of the Project area where aerial photograph coverage is unavailable);
- chest waders and life jackets (for each team member);
- wading staff (for stability and identifying deep water); and
- data collection form FISH-06 (at least 3 copies per day; appendix D).

9.2.1.3 Schedule

Adult migration and spawning monitoring will be conducted twice a month in October, November, and February–mid-April prior to Project construction and for the first 10 years after Project construction (chapter 2). Specifically, Chinook salmon will be the focus of October and November monitoring, and steelhead will be the focus of February–mid-April monitoring.

9.2.1.4 Location and Access

Adult migration and spawning will be monitored in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek (figures 1-2 and 1-3); and areas upstream of the Project area known to support spawning. These areas include the Upper Guadalupe River (i.e., in the vicinity of Foxworthy Avenue and from Branham Lane to the Alamitos drop structure), Los Gatos Creek (i.e., from Lincoln Avenue to Bascom Avenue), upper Guadalupe Creek (i.e., from Masson Dam to the confluence with Shannon Creek), and Alamitos Creek (i.e., from Almaden Lake to the Calero Creek confluence). Access to these areas requires coordination with the SCVWD.

9.2.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor adult migration and spawning. These steps are described in detail later in this chapter. Consult the *California Salmonid Stream Habitat Restoration Manual* (Flossi et al., 1998) for further description of monitoring protocols.

To monitor adult migration and spawning, the monitoring team will

- monitor stream flows using data posted on the SCVWD web site;
- measure water clarity using a Secchi tube;
- look for steelhead and Chinook salmon, both live fish and carcasses;
- look for steelhead and Chinook salmon redds;
- map the location of live fish, carcasses, and redds on the aerial photographs; and

- record adult migration and spawning data on data collection form FISH-06.

9.2.1.5.1 Mapping and Documentation

In the Office

1. Obtain stream flow data for the area to be surveyed from stream gages located in the vicinity. Stream flow data maintained by the SCVWD can be accessed on the Internet at alert.valleywater.org/gagestrm.html.
    - For the Guadalupe River, use the USGS gage on Guadalupe River upstream of the Highway 101 bridge (gage number 11169025).
    - For Guadalupe Creek, use the SCVWD gage downstream of Guadalupe Reservoir (gage number 17).
    - For Los Gatos Creek, use the SCVWD gage on Los Gatos Creek at Lincoln Avenue (gage number 50).
    - For Alamitos Creek, use the SCVWD gage on Alamitos Creek downstream of Almaden Reservoir (gage number 16).
2. Record the stream flow data on data collection form FISH-06.

Note: Use 1 data collection form for each day you record data. If you completely fill out a data collection form in a single day, continue on a second form for that day.

In the Field

3. Begin monitoring at the downstream end of the stream segment to be monitored.
    - For the Guadalupe River, begin monitoring at the Airport Parkway bridge in Reach A and continue monitoring to Grant Street at the upstream end of Segment 3C.
    - For Guadalupe Creek, begin monitoring at Almaden Expressway bridge and continue monitoring to the confluence of Shannon Creek.
    - For the Upper Guadalupe River, begin monitoring at Branham Lane and continue monitoring to the Alamitos drop structure. In addition, monitor in the vicinity of Foxworthy Avenue.
    - For Los Gatos Creek, begin monitoring at Lincoln Avenue and continue monitoring to Bascom Avenue.
    - For Alamitos Creek, begin monitoring at the inlet to Almaden Lake and continue monitoring to the Calero Creek confluence.
4. Indicate the geographic location of the start point and end point for each segment monitored on each monitoring day on the data collection form.

5. Measure water temperature (°F) and take a Secchi tube reading at the start of each day, following manufacturer's instructions. If water clarity appears to change substantially during the day, take additional Secchi tube readings. Record Secchi tube readings to the nearest millimeter and water temperature to the nearest 0.5 °F on the data collection form. Record the time of day each time measurement is taken. If water clarity is less than 18 inches, wait until clarity improves before monitoring the adult migration and spawning indicator.
6. Walk upstream either in the stream channel or on the channel bank. If walking in the stream channel, use a wading staff for stability and to identify deep water.
7. Look for steelhead and Chinook salmon, both live fish and carcasses. Wear polarized sunglasses to reduce glare off the water surface and allow for improved underwater visibility.

    a. For both live fish and carcasses, use the following alpha-numeric naming convention on the data collection forms and aerial photographs to label each live fish or carcass observed: water year, 4-letter abbreviation for fish, and a 3-digit consecutive number for each fish, beginning with 001. For example, the first live fish or carcass observed in WY 2001 would be labeled 01-FISH-001.

    b. For each live adult salmonid, record on the data collection form the stream segment, live fish identification number, species, sex (if possible), and habitat type where fish was observed (i.e., pool, riffle, or run). Record the location of the live fish on the aerial photograph. If aerial photograph coverage is not available for the segment being monitored, record the GPS identification number for the location of the live fish on the data collection form. Provide a narrative description of the location of the live fish on the data collection form under "Comments."

    c. For each salmonid carcass, record on the data collection form the stream segment, carcass fish identification number, species, fork length (to nearest centimeter from tip of snout to middle of tail), and sex. Examine the carcass for adipose fin clips or any other mark or tag. With a knife or machete, cut off the head, to indicate that the carcass has been recorded. If the carcass is missing an adipose fin, place the head in a freezer bag along with a coded-wire-tag recovery form (figure 9-1) wired to the jaw. Record the location of the carcass on the aerial photograph. If aerial photograph coverage is not available for the segment being monitored, record the GPS identification number for the location of the carcass on the data collection form. Provide a narrative description of the location on the data collection form under "Comments."

    Note: Each head removed from a carcass missing an adipose fin should be bagged individually and placed in the freezer on the same day it is collected. The frozen heads are to be delivered to the SCVWD for forwarding to California Department of Fish and Game (DFG).

8. Look for steelhead and Chinook salmon redds. Redds are usually found in shallow, fast-moving water with gravel substrate.
    a. Use the following alpha-numeric naming convention on the data collection forms and aerial photographs to label each redd observed: water year, 4-letter abbreviation for redd, and a 3-digit consecutive number for each redd, beginning with 001. For example, the first redd observed in WY 2001 would be labeled 01-REDD-001.
    b. Record on the data collection form the redd identification number and the habitat type where the redds were observed. Use a single line on the data collection form for each redd observed.
    c. Visually estimate the average gravel size used in the redds, and record the size on the data collection form. Suitable gravel sizes range from 6 to 102 millimeters (0.25 to 4 inches).
    d. Measure water depth (to nearest 0.1 foot) and water velocity (to nearest 0.1 foot per second) immediately upstream of redds using a wading rod and flow meter. Record data on the data collection form. Avoid stepping on redds, which can result in mortality to incubating eggs, when taking these measurements.
    e. Record the location of the redd on the aerial photograph. If aerial photograph coverage is not available for the segment being monitored, record the GPS identification number for the location of the redd on the data collection form. Provide a narrative description of the redd location on the data collection form under “Comments.”

9. At the end of the day, or when conditions substantially change, take another Secchi tube reading and water temperature measurement, and record these data and the time of day these measurements were taken on the data collection form.

In the Office

10. Place carcass heads in freezer, and contact the SCVWD to arrange delivery of frozen heads.

11. Download the GPS data.

12. Record the appropriate stream flow measurement using the field-measured flow data collected during the depth and velocity barrier monitoring.
    - For fish occurrences in Reach A or Segment 1, use stream flow data measured at Airport Parkway.
    - For fish occurrences in Segments 2 or 3A and Segment 3B upstream to the Los Gatos Creek confluence, use stream flow data measured in Segment 2 downstream of Coleman Avenue.

- For fish occurrences in Segment 3B upstream of the Los Gatos Creek confluence, the Woz Way to Park Avenue Bypass, and Segment 3C, use stream flow data measured in Segment 3C at Woz Way.
- For fish occurrences in Guadalupe Creek, use stream flow data measured at Almaden Expressway.

9.2.1.5.2 Immediate Remedial Actions Required

No immediate remedial actions are required for the adult migration and spawning indicator.

9.2.2 Data Management

Adult migration and spawning data will be collected twice a month in October, November, and February–mid-April prior to Project construction (preproject) and for the first 10 years after Project construction (MYs 1–10). Adult migration and spawning data are recorded on data collection form FISH-06. This indicator is recorded for each live fish, carcass, and redd. Adult migration and spawning data are stored in GEMS: data collected on data collection form FISH-06 are entered in the RDBMS, and data collected on aerial photographs are entered in the GIS database.

9.2.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the adult migration and spawning indicator:

- tblAdultMigrationSpawn (primary data table),
- tblStreamSegment,
- tblStartPoint,
- tblEndPoint,
- tblStreamGage,
- tblStream,
- tblAMSFish,
- tblFishSpecies,
- tblFishType,
- tblSex,
- tblMort,
- tblHabitatType,

- tblAMSMeasure,
- tblAMSRedd,
- tblAMSTeam, and
- tblMembers.

Figure B-25 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

9.2.2.2 Data Entry

Data from the FISH-06 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS.

9.2.2.3 Quality Assurance

Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

9.2.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry.

- stream segment,
- stream gage number,
- 5-letter species code,
- sex,
- live or carcass, and
- habitat type.

9.2.2.4 Data Structure and Entry for Aerial Photographs

Adult migration and spawning locations are recorded as points on aerial photographs. Aerial photographs annotated in the field with live fish, carcass, and redd locations will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized points will be attributed with live fish, carcass, or redd identification numbers. All points for a given monitoring year will be included in 2 shapefiles named

"Anadromous_Fish_Occurrence_<occurrence category>_mmmyy," where "occurrence category" is fish (i.e., live fish or carcass) or redd, "mmm" is month (e.g., "jan"), and "yy" is year (e.g., "01").

9.2.3 Data Analysis and Evaluation

The analysis and evaluation of the adult migration and spawning monitoring data assesses whether the measurable objective is met. The measurable objective for the adult migration and spawning indicator is that the Guadalupe River continues to support migration and spawning of adult steelhead and Chinook salmon at a level that is consistent with preproject conditions. The adult migration and spawning indicator also includes subobjectives that confirm

- adult migration and spawning occur at water temperatures consistent with the measurable objectives for the monthly thermal suitability and short-term thermal suitability indicators,
- adult migration through the Project area is consistent with conclusions based on evaluation of measurable objectives for the depth and velocity and vertical barrier indicators, and
- spawning occurs in gravel that is included in the measurable objective for the spawning gravel abundance indicator.

9.2.3.1 Calculations

Calculate the following variables for each monitoring activity date by monitoring year for steelhead and Chinook salmon:

- *total number observed redds*,
- *total number adult fish*, and
- *total number carcasses.*

9.2.3.2 Statistical Analysis Methods

Prepare the following graph:

- *total number of observed redds, adult fish,* and *carcasses* versus *time*.

9.2.3.3 Comparison to Measurable Objective

Use the graph described above to identify year-to-year variation in abundance. Look at other indicators (e.g., measured water temperature, depth and velocity and vertical barriers, and spawning gravel abundance and quality) to help determine possible reasons for variation and confirmation of the subobjectives. After MY 10, use the data to determine future monitoring needs.

9.3 Juvenile Rearing Indicator

The anadromous fish occurrence juvenile rearing indicator represents the occurrence of juvenile steelhead in the Project area. The purpose of monitoring this indicator is to provide information on the adequacy of spawning and rearing habitat for steelhead. The data on presence or absence of juvenile steelhead will improve estimates for the timing and distribution of the life stage. Observations may also confirm habitat use associated with channel types, instream cover, water temperature, and other environmental conditions. The additional information on habitat use may aid the assessment of the adequacy of instream cover (chapter 5), spawning gravel abundance and quality (chapter 7), water temperature (chapter 6), and rearing habitat diversity (chapter 8) indicators for monitoring Project effects. The measurable objective for the juvenile rearing indicator is that the Guadalupe River continue to support juvenile rearing at a level that is consistent with preproject conditions and environmental conditions not affected by the Project.

9.3.1 Data Collection

9.3.1.1 Permit and Special Reporting Requirements

Scientific take permits or authorization for monitoring of the juvenile rearing indicator are required from NOAA Fisheries because steelhead is a threatened species under the ESA. A supplemental BO (dated October 28, 2003) under Section 7 of the ESA has been issued for the Project by NOAA Fisheries (McInnis pers. comm.) (appendix I). The juvenile rearing indicator methodology which follows in this section has been reviewed and approved by NOAA Fisheries and is consistent with the terms in the supplemental BO.

Scientific Collecting Permits are required by DFG for all fish monitoring that includes collection activities. At a minimum, all field crew leaders must have a Scientific Collection Permit and written approval from the DFG district fishery biologist prior to monitoring the juvenile rearing indicator. The crew leaders must keep the written approval in their possession while collecting.

The following coordination with NOAA Fisheries and DFG is required prior to the initiation of monitoring of the juvenile rearing indictor for each monitoring year:

- provide a schedule for the monitoring year, including expected timing and duration, specific take methods, locations, species to be taken, number of individuals expected to be captured, and number that may be killed;

- provide a list of the lead field personnel and include names, qualifications, professional experience, DFG Scientific Collecting Permit number, and contact information; and
- provide a list of subordinate field personnel and include names and qualifications, if possible; at a minimum, identify the number of subordinate field personnel and their qualifications.

Special reporting requirements have been identified in the supplemental BO and in the terms of the DFG Scientific Collecting Permit beyond those described in chapter 10 for the juvenile rearing indicator. These include

- notifying NOAA Fisheries and DFG within 24 hours if steelhead mortality exceeds 5% of the total number of steelhead captured at any single sampling area or cumulatively during monitoring of the juvenile rearing indicator,
- providing preliminary results from the monitoring of the juvenile rearing indicator to NOAA Fisheries and DFG within 1 week following completion of the monitoring activity, and
- providing a preliminary report of the results of monitoring of the juvenile rearing indicator to NOAA Fisheries and DFG within 5 months of the last monitoring date; this preliminary report should include documentation of any take (i.e., the number of captured fish and the number of fish released in poor or dead condition) and a comparison of the cumulative annual take to the estimated take in the supplemental BO.

In addition, the DFG district fishery biologist and the warden for the area should be contacted at least 24 hours, or as specified in the DFG Scientific Collecting Permit, prior to beginning monitoring of the juvenile rearing indicator.

All notification and reporting should be directed to Protected Resources Division Supervisor, NOAA Fisheries, Santa Rosa Area Office, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404; telephone number 707/575-6050; facsimile number 707/578-3435.

Copies of any reports or publications related to collections of steelhead should be sent to Kathleen Perry, Department of Fish and Game, Native Anadromous Fish and Watershed Branch, P.O. Box 944209, Sacramento, CA 94244-2090; telephone number 916/651-8922.

9.3.1.2 List of Equipment

In addition to basic field monitoring equipment, the monitoring team will need the following specialized equipment:

- aerial photographs used to map the rearing habitat diversity indicator (section 8.4.1.2);

  Note: The original aerial photographs used to map the rearing habitat diversity indicator may be used for mapping the sampling area.

> *Alternatively, if data loss is a concern, copies of the photographs may be used.*

- backpack electroshocker with capability for varying voltage, pulse width, and pulse rate (using 2 electroshockers can increase efficiency of the monitoring effort for channel sections that are wide);
- block nets, dip nets, and large aquarium net;
- 5-gallon plastic buckets for collecting fish during electrofishing (referred to here as *collection buckets*) (at least 5);
- perforated 5-gallon plastic buckets for holding fish (referred to here as *holding tanks*) (at least 10: 4 for use as holding tanks and 6 for use as recovery tanks) (alternatively, 5-gallon buckets with battery-operated aerators may be used as holding and recovery tanks);
- resource agency–approved fish anesthetic;
- fish measuring board;
- hand-held thermometer (°F) (for measuring water temperature);
- Secchi tube;
- 100-foot-long measuring tape;
- chaining pins (2) (to secure the measuring tape);
- ice (for cooling water in holding tanks);
- permanent color pens for marking on the aerial photographs;
- pin flags (4);
- stadia rod (marked in tenths of a foot);
- chest waders and life jackets (for each team member);
- wading staff (for stability and identifying deep water);
- copies of the previous monitoring year's completed data collection forms for the rearing habitat diversity indicator (data collection form FISH-05); and
- data collection forms FISH-07-01 and FISH-07-02 (at least 20 copies for each day or sufficient forms to record daily fish captures) and SRA-07 (at least 10) (appendix D).

9.3.1.3 Schedule

Juvenile rearing will be monitored once a year in September or October for 10 years after Project construction (MYs 1–10; chapter 2).

9.3.1.4 Location and Access

Juvenile rearing will be monitored in Reach A; Segments 1, 2, 3A, 3B, and 3C; Woz Way to Park Avenue Bypass; and Guadalupe Creek (figures 1-2 and 1-3). Juvenile rearing will be monitored in up to 20 sampling areas: 12 in Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass and 8 in Guadalupe Creek (4 between Almaden Expressway and Masson Dam and 4 within 2 miles upstream of Masson Dam). Access to these areas requires coordination with the SCVWD.

9.3.1.5 Field Methods

Below is a list that *summarizes* key field methods that the monitoring team will perform to monitor juvenile rearing. These steps are described in detail later in this chapter.

To monitor juvenile rearing, the monitoring team will

- identify sampling areas based on rearing habitat diversity monitoring from the previous monitoring year and map the sampling reaches on aerial photographs,
- measure water temperature and take Secchi tube reading at each of the 20 sampling areas,
- sample target habitat types with a backpack electroshocker, and
- record juvenile rearing data on data collection forms FISH-07-01 and FISH-07-02.

9.3.1.5.1 Mapping and Documentation

In the Office

1. Identify potential sampling areas, using the aerial photographs from the rearing habitat diversity monitoring. Potential sampling areas must meet the following criteria:
    - each sampling area encompasses a stream length of 100 feet (some sampling areas may be less than 100 feet) (riffles are often less than 50 feet long);
    - each sampling area includes pool-riffle-run, pool-riffle, pool-run, or run-riffle sequences (at least 2 habitat types must be included in each sampling area);
    - each sampling area begins or ends within a habitat type (does not need to encompass the entire pool, riffle, or run) (block nets will define the upstream and downstream limits of sampling areas);

- individual pools, riffles, or runs in each sampling area represent no more than 50 feet of the entire sampling area; and
- sampling areas do not include pools that are too deep to be effectively sampled with a backpack electroshocker.

2. Delineate the potential sampling areas on the aerial photographs.
3. From the potential sampling areas, select 12 sampling areas in Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass and 8 sampling areas in Guadalupe Creek (4 between Almaden Expressway and Masson Dam and 4 within 2 miles upstream of Masson Dam).
   - Sampling areas should be distributed relatively evenly throughout the respective reaches.
   - Of the 12 sampling areas in Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass, at least 3 sampling areas should be in armored channel sections and the remaining sampling areas in natural channel sections (i.e., unarmored).
4. Mark the selected sampling areas on the aerial photographs. In addition, mark at least 3 alternate sampling areas in Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass and at least 2 alternate sampling areas in Guadalupe Creek (1 between Almaden Expressway and Masson Dam and 1 within 2 miles upstream of Masson Dam).
5. Be sure you are familiar with the use of depletion estimates and surrogate species to confirm sampling effectiveness (Van Deventer and Platts, 1986).

In the Field

6. Using the aerial photographs, locate the sampling area and confirm its suitability for electrofishing.

   Note: If the site does not meet the criteria in step 1 or is otherwise not suitable for electrofishing, replace the selected sampling area with 1 of the alternate sampling areas, and move to the next sampling area.

7. Mark the actual beginning and end of each sampling area on the aerial photograph, and record the stream segment, sampling area identification number, and rearing habitat identification number (described below) on data collection form FISH-07-01.
   - Use the following alphanumeric naming convention on the data collection forms and aerial photographs to label each sampling area: the 2-digit water year, the 4-letter abbreviation for juvenile rearing, and a 3-digit consecutive number for each juvenile rearing sampling area, beginning with 001. For example, the first juvenile rearing sampling area in WY 2002 would be labeled 02-JUVE-001.

- Record the length of the rearing habitat that is sampled and the rearing habitat type on data collection form FISH-07-01. Use a separate data collection form for each habitat type sampled at each sampling area. For example, juvenile rearing sampling area 02-JUVE-001 would require 2 data collection forms, 1 for each habitat type sampled, if the sampling area comprised 2 habitat types (e.g., a run and a riffle). Use an additional data collection form if the sampling area contains 3 habitat types.

8. Measure water temperature (°F) using the hand-held thermometer, at the sampling area to be monitored.
   - If water temperature is 64 °F or cooler, proceed to step 9.
   - If water temperature exceeds 64 °F, select a different sampling area that is cooler than 64 °F or delay sampling until later in the day when water temperatures are cooler.

   Note: The supplemental BO requires that water temperature be 64 °F or cooler for sampling to occur (appendix I).

9. Set at least 2 block nets to prevent fish from moving out of the rearing habitat you are sampling during electrofishing—1 at the downstream end of the rearing habitat and 1 at the upstream end.
10. Take a Secchi tube reading to the nearest millimeter. Record the data on data collection form FISH-07-01.
11. Record the sampling area identification number, rearing habitat identification number, electrofishing pass number, and start time of the electrofishing pass on data collection form FISH-07-02. Use a separate data collection form for each electrofishing pass.
12. Prepare holding tanks (i.e., perforated buckets or buckets with battery-operated aerators).
    - If perforated buckets are used, place them securely in the river.
    - If buckets with aerators are used, water temperature in the buckets will need to be monitored and fresh river water will need to be added as necessary to maintain fish in good condition.
13. Begin monitoring at the downstream end of the rearing habitat. Set the voltage, pulse width, and pulse rate of the electroshocker at minimum values needed to capture fish. Increase settings gradually only to the point where fish are immobilized for capture. Record these settings on data collection form FISH-07-02.

    Note: Monitoring tasks are typically divided up among the monitoring team as follows: 1 person electroshocking, 2 people netting, and 1 person carrying buckets and maintaining fish. For larger areas with larger teams, the team may have 2 people electroshocking, 3 people netting, and 1 person carrying buckets and maintaining fish.

14. Sample for juvenile steelhead while moving slowly upstream, using 1 or more backpack electroshockers, depending on the width of the channel. Systematically sample the entire wetted channel, being certain to cover likely microhabitats, such as pocket water, woody material, undercut bank, fast water, and backwater pool, within each rearing habitat. Minimize the time that fish are exposed to the electric field by quickly netting them and removing them from the water.

15. Place captured fish in collection buckets. To avoid overcrowding, periodically transfer captured fish to holding tanks. If fish appear stressed in holding tanks, take 1 or more of the following measures.

    - Reduce the number of fish per bucket by moving some fish to other buckets.

    - Add small amounts of ice to reduce water temperatures. Temperature reductions should be made gradually and should not be more than 5 °F. Water temperatures in holding tanks should be returned to river water temperature before fish are released.

16. Collect biological data on captured fish immediately after sampling. Anesthetize fish with a resource agency–approved anesthetic to reduce stress caused by handling. Process salmonids first, then other native species, and then nonnative species. Record the following information on data collection form FISH-07-02.

    a. For each salmonid individual and for a random sample of at least 30 individuals of each other species, record:

        - 5-letter species code,
        - fork length (to the nearest millimeter),
        - microhabitat type for salmonids (e.g., pocket water, woody material, undercut bank, fast water, or back water pool),
        - life stage assessment for salmonids (table 9-1), and
        - comments (include notes on steelhead mortality).

    Notes: Record information pertaining to the microhabitat type from which juvenile steelhead are collected where practicable. For example, in sampling areas where only a few juvenile steelhead are collected, it should be possible to indicate the specific microhabitat type from which the juvenile steelhead were collected. For sampling areas where many juvenile steelhead are collected, it may only be possible to estimate what proportion of the captured fish were associated with which microhabitat types, based on professional judgment.

    If it appears that fewer than 30 individuals of a species were collected, record data for all individuals.

    b. For nonsalmonid species beyond the random sample of 30 individuals, record:

- 5-letter species code and
- a tally of the number of individuals sampled.

Table 9-1. Life-Stage Assessment Protocol for Juvenile Salmonids

Code	Life Stage	Criteria
1	Yolk-sac fry	Newly emerged with visible yolk sac
2	Fry	Recently emerged with yolk sac absorbed (“button-up fry”) Pigmentation undeveloped
3	Parr	Darkly pigmented with distinct parr marks No silvery coloration Scales firmly set
4	Silvery parr	Parr marks visible but faded Intermediate degree of silvering
5	Smolt	Parr marks highly faded or absent Bright silver or nearly white coloration Scales easily shed (deciduous) Black trailing edge of caudal fin More slender body (i.e., lower condition)

Source: Interagency Ecological Program, 1998.

17. Record the end time of the electrofishing pass and the elapsed time expended to complete the electrofishing pass between the block nets on data collection form FISH-07-02.
18. After collecting biological data, place fish in a holding tank to recover.
    - Place salmonids in a recovery tank separate from other fish species to reduce stress on salmonids from overcrowding.
    - Keep fish in holding tank until all electrofishing passes are completed and biological data on all captured fish are collected. Fish from subsequent electrofishing passes should be placed in separate recovery tanks to avoid overcrowding.
19. Repeat steps 8–18 two more times, so that the rearing habitat is sampled at least 3 times. Use a separate copy of data collection form FISH-07-02 for each electrofishing pass. The number of electrofishing passes may exceed 3, if necessary, to achieve an adequate estimate of total steelhead abundance (Van Deventer and Platts, 1986). If the number of steelhead is low and does not support calculation of depletion estimates, a surrogate species (e.g., Sacramento sucker or California roach) may be used to confirm the sampling effectiveness and the need for more than 3 passes.
20. Allow fish to recover in the holding tanks for at least 15 minutes before returning them to the stream. Release all fish back into the habitat types from which they were collected as soon as possible.

21. Record on data collection form FISH-07-01 the number of steelhead released in the following condition:
    - good (fish immediately swam to cover),
    - fair (fish oriented with the current and moved slowly to cover),
    - poor (fish had difficulty orienting with the current and swimming to cover), and
    - dead (fish died).
22. Measure the water temperature (°F), using the hand-held thermometer, in the rearing habitat after fish have been released, and record it on data collection form FISH-07-01.
23. Visually estimate the percentage of the stream surface in the rearing habitat that is shaded by overhanging vegetation. Record the estimate on data collection form FISH-07-01.
24. Return to the downstream end of the rearing habitat and measure off 10-foot segments along the right or left bank.
25. For each 10-foot segment, record on data collection form FISH-07-01
    - the downstream tape measurement (e.g., 0 foot, 10 feet, 20 feet),
    - the percentage of instream cover (use data collection form SRA-07 to calculate the percentage of instream cover for each 10-foot segment), and
    - the dominant substrate in the segment (i.e., clay, sand, gravel, cobble, riprap).
26. Repeat steps 6–25 for the remaining habitat type(s) in the sampling area.

9.3.1.6 Immediate Remedial Actions Required

No immediate remedial actions are required for the juvenile rearing indicator.

9.3.2 Data Management

Juvenile rearing data will be collected once a year in September or October for 10 years following Project construction (MYs 1–10). Juvenile rearing data are recorded on the FISH-07-01 and FISH-07-02 data collection forms. Indicator is recorded for each fish. Juvenile rearing data are stored in GEMS: data collected on data collection forms FISH-07-01 and FISH-07-02 are entered in the RDBMS, and data collected on aerial photographs are entered in the GIS database.

9.3.2.1 Data Structure

The following primary data table (section 3.4.2.1.1) and metadata tables (section 3.4.2.1.2) in the RDBMS are used to store data relating to the juvenile rearing indicator:

- tblJuvinileRearing (primary data table),
- tblStreamSegment,
- tblJRRH,
- tblHabitatType,
- tblJRElectroFish,
- tblJRMeasuredFish,
- tblFishSpecies,
- tblFishType,
- tblJRNonMeasuredFish,
- tblJRTeam, and
- tblMembers.

Figure B-26 in appendix B shows the relationships between the primary data table and the metadata tables for the indicator.

9.3.2.2 Data Entry

Data from the FISH-07-01 and FISH-07-02 data collection forms will begin to be entered into the RDBMS within 1 week after completion of the monitoring activity. The data are input into the RDBMS using a data entry form that electronically interfaces with the RDBMS. After the values for *estimated total number* and *density of juvenile steelhead* for each rearing habitat type in each sampling area are calculated (section 9.3.3.1), enter the values in the data entry form for each sampling area in the RDBMS.

9.3.2.3 Quality Assurance

- Data quality assurance methods are completed as described in chapter 3. The following quality assurance check is performed during data entry by the RDBMS software.

9.3.2.3.1 Lookup Values

Lookup values are used for the following data entry fields to ensure that only valid values can be input during data entry:

- stream segment,
- rearing habitat type sampled,
- dominant substrate,
- pass number,
- 5-letter species code,
- microhabitat type, and
- life stage assessment.

9.3.2.4 Data Structure and Entry for Aerial Photographs

Juvenile rearing sampling locations are recorded as lines on aerial photographs. Aerial photographs annotated in the field with juvenile rearing sampling locations will be converted into GIS data by a GIS specialist. A GIS layer will be created using the aerial photographs as the base map. The digitized lines will be attributed with juvenile rearing identification numbers. All lines for a given monitoring year will be included in 1 shapefile named "Anadromous_Fish_Occurrence_Juvenile_Rearing_mmmyy," where "mmm" is month (e.g., "jan") and "yy" is year (e.g., "01").

9.3.3 Data Analysis and Evaluation

The analysis and evaluation of the juvenile rearing monitoring data assesses the measurable objective of continued support of juvenile rearing in the Guadalupe River at a level that is consistent with preproject conditions and environmental conditions not affected by the Project. In addition, the juvenile rearing data are used to assess the relationship between habitat use and specific environmental conditions, including water temperature, channel structure and type, instream cover, overhead cover, and substrate.

9.3.3.1 Calculations

Calculate for the Guadalupe River and Guadalupe Creek the *estimated total number* and *density of juvenile steelhead in sampling areas* by *monitoring year*. Use a statistical-based software package (e.g., Microfish 3.0) for processing electrofishing data.

9.3.3.2 Statistical Analysis Methods

Prepare the following table:

- *estimated number of juvenile steelhead* versus *environmental conditions* (including Secchi tube readings, water temperature, channel structure and type, instream cover, shaded stream surface, and substrate) by *rearing habitat type*.

Prepare the following graphs:

- *estimated total number* and *density of juvenile steelhead* by *monitoring year*,
- *longitudinal distribution observed for juvenile steelhead in the Guadalupe River* by *monitoring year*, and
- *total mortality of steelhead* and *observations on fish health upon release* (i.e., good, fair, poor, or dead) by *monitoring year*.

9.3.3.3 Comparison to Measurable Objective

Use the graphs to identify year-to-year variation. Assess the occurrence of juvenile steelhead, and document variability over multiple years of sampling. Discuss occurrence relative to preproject sampling. Assess the consistency between the environmental conditions in occupied habitat and the measurable objectives for the instream cover, spawning gravel abundance and quality, monthly thermal suitability, and rearing habitat diversity indicators for monitoring Project effects. Determine the need for additional monitoring or a change in monitoring method. After MY 10, use the data to determine future monitoring needs.

Chapter 10

Guadalupe River Annual Mitigation Monitoring Report Format and Content

Staff member preparing report

10.1 Purpose

The goals of the annual mitigation monitoring report are to

- document the comparison of the current monitoring year's data to the MMP's measurable objectives,
- provide the Adaptive Management Team with the information necessary to determine if the measurable objectives are being met,
- identify potential remedial measures if trends indicate that future measurable objectives will not be met, and
- provide suggestions to modify the MMP as indicated by monitoring results.

Note: *Additional reporting requirements for the adult migration and spawning and juvenile rearing indicators are described in chapter 9.*

10.2 Suggested Format and Content

The format and content of the annual mitigation monitoring report are described below.

- "Executive Summary" provides a nontechnical summary of the background, methods, results, recommendations, and conclusions, based on the current monitoring year's data. It emphasizes the status of progress toward the measurable objectives and any recommended remediation or modification of the MMP.

- "Introduction" gives a brief background of the mitigation and monitoring program and describes the implementation components and schedule. It also includes brief summaries of the mitigation and monitoring objectives and the adaptive management process. Lastly, it provides the organization and purpose of the report.
- "Methods" provides a description of the monitoring procedures and materials. It first gives a brief overview of the overall monitoring program, including the monitoring frequency and schedule. It then describes differences between the monitoring methods that were used and the MMP. For each monitoring component, it discusses the data collection methods and data analysis methods.
  - ☐ "Data Collection" summarizes the data collection process, with emphasis on methods or schedules that were different from those outlined in the previous annual mitigation monitoring report. In addition, this section provides a brief summary of the data collected.
  - ☐ "Data Analysis and Evaluation" summarizes the data analysis methods used for the indicator. It describes the analysis tools that are used and briefly justifies the methods chosen. This section provides a summary of the results of data analysis and evaluation, including summary tables and graphics. Any special conditions or irregularities in the data are discussed.
- "Results" discusses the monitoring results, using graphs, tables, and text. It provides a summary of the weather conditions and other environmental conditions that have affected the mitigation area during the year. For each indicator, it provides a discussion of monitoring results, including "Comparison to Measurable Objectives" and "Remedial Actions" sections.
  - ☐ "Comparison to the Measurable Objectives for Indicator" reviews the measurable objectives for the indicator and compares them to the current year's monitoring results. Discrepancies between the measurable objective and the monitoring results are interpreted.
  - ☐ "Remedial Measures" provides suggested remedial measures to address deficiencies in meeting measurable objectives. Some possible remedial measures are described by indicator in the MMP.
- "Recommendations" provides recommendations to the Adaptive Management Team based on the current monitoring year's and previous monitoring years' results. The recommendations will include any adaptive management measures deemed necessary, including remedial actions or modifications to the MMP.
- "Conclusions " summarizes the main findings of the evaluation of the monitoring results. It also provides an assessment of the status of the mitigation and monitoring program.

- "References" provides full documentation of the literature cited in the report and any personal communications that were cited in the report.

- "Appendices" may be included. They may include a list of the members of the Adaptive Management Team for the year, data tables that were too detailed for inclusion in the main body of the text, technical data reports, and other materials.

10.3 Schedule

The MMP requires that an annual mitigation monitoring report be prepared by March 31 for every year of the Project's monitoring program (MMP section 3.3.2). The report will summarize monitoring data collected during the previous WY (October 1 – September 30). The report will be prepared by the Corps during construction and also during postconstruction MYs 1–3. The report will be prepared by SCVWD during postconstruction MYs 4–40. Annual reports will be prepared through MY 40 or until the Adaptive Management Team determines that the measurable objectives have been attained and reporting is no longer necessary.

10.4 Distribution

The MMP requires that the annual mitigation monitoring report be distributed to the following local, state, and Federal entities:

- City of San Jose;
- SCVWD;
- California State Water Resources Control Board;
- DFG;
- Natural Heritage Institute, which represents the Guadalupe–Coyote Resource Conservation District, Pacific Coast Federation of Fishermen's Associations, and Trout Unlimited;
- San Francisco Bay Regional Water Quality Control Board;
- Corps, Sacramento District;
- NOAA Fisheries;
- U.S. Fish and Wildlife Service; and
- landscape revegetation contractor (if one is under contract – optional submittal).

Chapter 11

Report Preparation

11.1 Introduction

The IP was prepared by Jones & Stokes under contract to the Corps, with contributions from Corps and SCVWD staff. The individuals responsible for preparing this report are listed below.

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Micah Rousey	Database Developer
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Chapter 12
References

12.1 Printed References

Armantrout, N. B. 1998. *Glossary of aquatic habitat inventory terminology*. Bethesda, MD: American Fisheries Society.

Crouse, M. R., C. A. Callahan, K. W. Malueg, and S. E. Dominguez. 1981. Effects of fine sediments on growth of juvenile coho salmon in laboratory streams. *Transactions of the American Fisheries Society* 110:281–286.

Daubenmire. 1968. *Plant communities.* New York, NY: Harper and Row.

Dingman, S. L. 1994. *Physical hydrology.* Englewood Cliffs, NJ: Prentice-Hall Inc.

Draper, N. R., and H. Smith. 1966. *Applied regression analysis.* New York, NY: John Wiley & Sons, Inc.

Flossi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. *California salmonid stream habitat restoration manual.* 3rd edition. Sacramento, CA: California Department of Fish and Game, Inland Fisheries Division.

Fris, M. B., and R. W. DeHaven. 1993. *A community-based habitat suitability index model for shaded riverine aquatic cover, selected reaches of the Sacramento River system.* Draft. Sacramento, CA: U.S. Fish and Wildlife Service.

Husch, B., C. I. Miller, and T. W. Beers. 1982. *Forest mensuration.* 3rd edition. New York, NY: John Wiley & Sons, Inc.

Interagency Ecological Program. 1998. *Steelhead life-stage assessment protocol.* Interagency Ecological Program Steelhead Project Work Team. Stockton, CA.

Jones & Stokes Associates, Inc. 1997. *HEP analysis of aquatic resources for downtown Guadalupe River flood control project.* February 21. (JSA 95-

116.) Final. Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA.

Jones & Stokes. 2002. *Water year 2001 mitigation monitoring report for the Guadalupe River Project, downtown San Jose, California*. Final. August. (J&S 02-076.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA, in coordination with Santa Clara Valley Water District, San Jose, CA.

__________. 2003. *Water year 2002 mitigation monitoring report for the Guadalupe River Project, downtown San Jose, California*. Final. February. (J&S 02-550.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA, in coordination with Santa Clara Valley Water District, San Jose, CA.

Pfankuch, D. J. 1975. *Stream inventory and channel stability evaluation: A watershed management procedure.* Washington DC: U.S. Department of Agriculture Forest Service, Northern Region R1-75-002, Government Printing Office.

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. *Habitat suitability information: Rainbow trout.* Washington, D.C.: U.S. Fish and Wildlife Service, Division of Biological Services (FWS/OBS-82d/10.60).

U.S. Army Corps of Engineers. 2001a. *Integrated general re-evaluation report/environmental impact report/supplemental environmental impact statement for proposed modifications to the Guadalupe River project, downtown San Jose, California.* Final. February. Volume 2b (*Guadalupe River flood control project, downtown San Jose, California, mitigation and monitoring plan*). Sacramento, CA. Prepared by U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA; Santa Clara Valley Water District, San Jose, CA; and Jones & Stokes, Sacramento, CA.

__________. 2001b. *Integrated general re-evaluation report/environmental impact report/supplemental environmental impact statement for proposed modifications to the Guadalupe River project, downtown San Jose, California.* Final. February. Volume 1. Sacramento, CA. Prepared by U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA; Santa Clara Valley Water District, San Jose, CA; CH2M HILL, Sacramento, CA; and Jones & Stokes, Sacramento, CA.

__________. 2004. [In prep.] *Simulation of water temperature for the Guadalupe River flood control project located in downtown San Jose, California*. Final. Prepared by Jones & Stokes, Sacramento, CA.

U.S. Department of Agriculture Forest Service. 1998. *Stream condition inventory guidebook.* Version 4.0. Vallejo, CA: Pacific Southwest Region.

U.S. Fish and Wildlife Service. 1982. *Habitat suitability index models: Appendix A. Guidelines for riverine and lacustrine applications of fish HSI* *models with the habitat evaluation procedures.* September. (FWS/OBS-82/10.A.) Washington, DC.

__________. 1984. *Habitat suitability information: Rainbow trout.* (FWS/OBS-82/10.60.)

Van Deventer, J. S. and W. S. Platts. 1986. Sampling and estimating populations from streams. *Trans. N. A. Wildlife and Natural Res. Confer.* 48:349-354.

12.2 Personal Communications

McInnis, Rodney R. Acting Regional Administrator. U.S. Department of Commerce/National Oceanic and Atmospheric Administration National Marine Fisheries Service, Long Beach, CA. October 28, 2003–letter.

Appendix A

Glossary

Appendix A
Glossary

Important terms used in this implementation plan (IP) are defined below. In limited cases, a term may have a meaning uniquely defined for the Guadalupe River Project (Project) that differs from the conventional meaning.

Term	Definition
Absolute cover	Percentage of ground surface (either total sampling plot area or transect length) covered by vegetation categories or plant species.
Abundance	Estimated numeric range that expresses plentifulness or scarcity.
Accretion	Inflow to a stream that does not come from a tributary. Generally, accretions come from groundwater or from surface runoff.
Adaptive management	A decision-making process to optimize the long-term implementation of flood protection measures on the Guadalupe River, with the objective of ensuring that ecological functions and habitat values affected by the Project are reestablished. Key components of adaptive management are identifying indicators for ecological functions and habitat values, setting measurable objectives (numerical and descriptive goals) for the indicators, monitoring the indicators, and planning and implementing remedial actions based on monitoring results and/or pilot projects.
Adaptive management team	A group of resource agencies and other stakeholder organizations with the responsibility to direct and implement the adaptive management process during Project construction and for the life of the Project (U.S. Army Corps of Engineers, 2001).
Adult migration and spawning indicator	Indicator used to measure presence or absence of adult steelhead and Chinook salmon occurrence and spawning in the Project area.
Aerial photograph signatures	Pattern, texture, and color on aerial photographs used to identify plant species.
Anadromous fish	Migratory fishes, such as steelhead and Chinook salmon, that hatch in freshwater, spend their adult lives in the ocean, and return to their natal stream to breed and die in freshwater.
Anadromous fish	Umbrella term for the 3 indicators related to anadromous fish occurrence: adult

occurrence monitoring component	migration and spawning, juvenile rearing, and juvenile migration indicators.
Anadromous fish passage and rearing habitat monitoring component	Umbrella term for the 3 indicators related to anadromous fish passage and rearing habitat: depth and velocity, vertical barrier, and rearing habitat diversity indicators.
Anadromous fish spawning habitat monitoring component	Umbrella term for the 2 indicators related to anadromous fish spawning habitat: spawning gravel abundance and spawning gravel quality indicators.
Aquatic vegetation growth	The stream surface covered by rooted vegetation that extends above the water surface (e.g., floating water primrose [*Ludwigia peploides*]); it does not include submerged or floating vegetation that is not rooted in the channel bottom or banks (e.g., duckweed [*Lemna* spp.]).
Armored channel sections	Bank and channel bottom sections in the Project area that have been covered with hardscape materials (e.g., concrete, interlocking concrete blocks, and gabions) to prevent erosion from anticipated high-velocity flows.
Average depth of a JSATEMP model segment	Overall average depth in a model segment. Average depth times average width times segment length equals water volume of the segment.
Average width of a JSATEMP model segment	The average wetted width of all channel cross sections in a model segment. Average depth times average width times model segment length equals water volume of the segment.
Backsight	Rod reading taken at a point of known elevation during channel bottom stability surveys.
Bank	Ground that slopes up from both sides of the streambed. When a bank is designated as a right bank or left bank, the orientation is relative to a person facing downstream. See also *top of bank*.
Bank height	Instability element consisting of moderately high to high bank height relative to surrounding banks.
Bank stability indicator	Indicator used to measure the percentage of stream bank with stable groundcover.
Barrier	See depth barrier, velocity barrier, or vertical barrier.
Basal area	See *tree basal area*.
Baseline aerial photographs	Baseline, natural color aerial photographs acquired in October 2000 at a nominal photograph scale of 1:3,600 (1 inch = 300 feet). These photographs are the baseline photographs identified in the MMP. They are semirectified to control points established by the SCVWD.
Bed	Bottom of a body of water, such as a stream.
Biltmore stick	Tool, consisting of a straight stick 24–36 inches long, used to estimate diameter at breast height. It is held perpendicular to the axis of a tree trunk and has gradations to determine the tree diameter.
Bridge shade fraction	*Stream area shaded by bridges* divided by *total segment area.*
Calibrate	To make adjustments to a water temperature logger or the JSATEMP model so that logger or model output is more accurate.
Canopy	Overhead cover of branches and foliage.
Chaining pin	Metal stake with eyehole at its top; used to secure a measuring tape to the ground.

Channel	Natural stream that conveys water; a ditch or channel excavated for the flow of water.
Channel bottom stability indicator	Indicator used to measure change in channel bottom elevation at selected cross sections in natural channel areas potentially affected by Project features.
Channel constriction	Area where water velocity exceeds 5 feet per second.
Chinook salmon	Largest species of the salmon family. Inhabits the northwest Pacific Ocean and spawns in rivers and streams of North America. The species has a number of races classified by the season in which they migrate into rivers to spawn (i.e., winter-run, spring-run, fall-run, and late fall–run are known to occur in California). Only fall-run Chinook salmon (*Oncorhynchus tshawytscha*) occur in the Guadalupe River.
California Irrigation Management Information System (CIMIS)	Stations that collect meteorological data, including air temperature, dew point temperature, solar radiation, and wind speed, appropriate to be applied to the Guadalupe River. CIMIS information for the Guadalupe River is used in the JSATEMP model to simulate water temperatures for the Project. Data from the station at Morgan Hill is used in the model. Until it was closed in 2002, data was used from the CIMIS station at San Jose International Airport.
CIMIS meteorological data	See CIMIS.
Clinometer	An instrument used to measure tree height using vertical angles.
Cohesive	Material that sticks together or is held together by interparticle cohesion.
Collected data	Data collected specifically for the Guadalupe IP. These data are used to determine whether the measurable objectives of the Project are being met. For the water temperature indicators, collected data are used in the calculations and quality assurance measures that need to be performed before JSATEMP model simulations can be run and in model simulations.
Conglomerate	A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than 2 millimeters in diameter, set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay (Bates and Jackson, 1984).
Constructed features	Flood protection features constructed as part of the Project; include armored channel sections (including constructed low-flow channel sections), invert stabilization control structures, and weirs.
Convection	Transfer of heat caused by the movement of gas or liquid. In this case, heat transfer between air and water caused by the movement of air over the water surface.
Coordinate	Measure of location in the California State Plane, Zone 3, North American Datum of 1983.
Cover class	Numeric range of the percentage of the vegetative canopy that consists of a particular vegetation category or plant species.
Cross-sectional area	Area formed by the width and depth of a stream channel measured perpendicular to the center line of flow.
Crown diameter	Average diameter of the crowns of the trees that shade the stream.
Crown height	Average vertical distance from the top of the tree to the water surface.
Cubic feet per second (cfs)	Unit of measure of stream flow that expresses the water volume (in cubic feet) passing a point per unit of time (in seconds).
Cultivar	Nonnative plant species or variety that is cultivated for horticultural or agricultural purposes.

Current-postproject	Postproject conditions during the current water year (e.g., water year 2004). Used because not all Project features have been constructed.
Data collection form	Forms used by staff collecting data in the field to record data. Each data collection form is associated with a specific indicator and has a unique identification number.
Data tables	Used to store the data, look up tables, and other miscellaneous tables. Data tables are conceptually similar to spreadsheets but have greater functionality to link and join together different types of data using primary keys.
Depletion	Loss of water from a stream, generally through percolation, diversion, or evaporation.
Depth and velocity indicator	Indicator that measures the number and location of potential and actual barriers to adult anadromous fish passage caused by high water velocity and/or shallow water depth.
Dew point temperature	Temperature at which water will condense out of the air.
Diameter at breast height (dbh)	Diameter of a tree trunk at 4.5 feet above the ground surface.
Diameter tape	Tape (graduated at intervals of π units) used to directly measure tree trunk diameter in inches, assuming the tree is circular in cross section. If the cross section is not circular, the measurement is slightly inflated.
Dieback	Gradual dying of plant tissue, progressing from the distal end of a stem, branch, or leaf.
Dissolved oxygen (DO)	Oxygen dissolved in water that is available to supply oxidation and respiration requirements.
Disturbance	Human- or animal-induced destruction of plant parts.
Dominant branches	Major branches of a tree canopy.
Down cutting	Lowering of the channel bottom by erosion.
Downed wood	Stability element consisting of logs firmly embedded into banks.
Drop structure	Constructed structure for dropping water to a lower level and dissipating the water's surplus energy. A drop structure may be vertical or inclined.
Ecosystem	Recognizable, relatively homogeneous complex that includes organisms, their environment, and the interactions between them.
Effective solar radiation	Average solar radiation reaching the water of a model segment; the *solar fraction for a model segment* times the *CIMIS full-sun measurement*.
Elevational unit	Elevational units are relative to the stream water surface and describe the elevation of the gravel in 1-foot increments. Negative numbers designate elevational units below the water surface, positive numbers designate elevational units above the water surface, and 0 is the water surface. For example, elevational unit –3 to –2 is between 2 and 3 feet below the water surface, and elevational unit 0 to +1 is between 0 and 1 foot above the water surface.
Embeddedness	Substrate attribute reflecting the degree to which larger particles (i.e., boulder, cobble, pebble, and large gravel) are surrounded by fine sediment (i.e., sand, silt, or clay). Fine sediment can fill the interstitial spaces between large particles and block water flow. Water flow is important to supporting benthic macroinvertebrates, small overwintering fish, some fish spawning, and egg incubation.
Environmental condition	Data collected to support indicators but for which there is no measurable objective.

parameter	For example, data from the measured water temperature, stream channel geometry, solar heat transfer, and stream flow environmental condition parameters are used to calculate the results of the short-term thermal suitability and monthly thermal suitability indicators.
Erosion	Wearing away of land surface by running water, including rainfall, waves, and currents.
Erosion-resistant soil	Stability element consisting of hardened conglomerate or cohesive clay/silt banks.
Field-measured data	Data collected specifically for the Project's monitoring program.
Field-measured stream flow	Estimate of water volume passing a point on a stream or river as determined in the field by measuring the width, depth, and average water velocity at discrete intervals across the stream width. Stream flow is then calculated by summing the measurements for each discrete interval.
Fish barrier	Natural or artificial structure that impedes or delays the upstream or downstream movement of a fish.
Flashboards	Boards placed at the top of a dam (e.g., the Alamitos drop structure) to raise the water level behind the dam.
Floodplain	Portion of a river valley that is adjacent to the channel, composed of sediment deposited by the stream, and overtopped during floods (Bates and Jackson, 1984).
Fluvial	Of or pertaining to rivers.
Foliage factor	Variable used in the JSATEMP model to approximately account for seasonal change in shade caused by winter leaf loss.
Foresight	Rod reading taken during channel bottom stability survey on a point whose elevation is to be determined.
Fracturing, blocking, or slumping	Cracks near the top of the bank, slumping banks, and blocks of soil/plant material that have fallen off or slid down the bank.
Fry (salmonid)	Early life stage of salmonid species comprising newly hatched fish that have not yet formed vertical bars (parr marks) on their sides.
Fry emergence indicator	Indicator used to quantify the survival of Chinook salmon eggs and young in spawning gravel.
Full-sun solar radiation measurement	Solar radiation measured, in watts per meter^2, under full sunlight.
Gage-measured data	Data not collected specifically for the Project's monitoring program (e.g., stream flow data measured at USGS or SCVWD stream flow gages).
Gaging weir	Structure on a stream, canal, lake, or reservoir where systematic observations of gage height or discharge are obtained.
GEMS	See Guadalupe Environmental Monitoring System.
Girdling	Inhibiting tree or shrub growth by tightly constraining or removing the bark.
Global positioning system (GPS)	System of earth-orbiting satellites and 1 or more receivers used to determine the elevation and coordinates of a location.
GPS unit	Hand-held instrument that can calculate the position and elevation of the unit on the surface of the earth.
Grab sample	Measurements or material (data) collected at irregular times.
Gravel bed	Natural accumulation or deposition of gravel-size particles (6–75 millimeters) on the channel bottom in areas of low water velocity, decreased gradient, or channel

	obstruction that is used by fish for habitat, including spawning.
Guadalupe Environmental Monitoring System (GEMS)	Integrated environmental information system. The primary component of GEMS is a relational database that is linked to GIS data, the JSATEMP model , and digital images (ground-level and aerial photographs).
Guadalupe River Project (Project)	Combined areas that make up the Project: area along the Guadalupe River between Grant Street and Interstate 880, the area along the Guadalupe River between Interstate 880 and Airport Parkway (Reach A mitigation site), and an area of Guadalupe Creek between Masson Dam and Almaden Expressway (Guadalupe Creek mitigation site).
Habitat	Place where an animal or plant normally lives, among its associated species and support systems, often characterized by a dominant plant and codominant form, such as pinyon-juniper habitat.
Habitat degradation	Destruction of natural elements necessary to support native species.
Habitat quality score	Numeric value assigned to fish habitat based on habitat characteristics beneficial to steelhead and Chinook salmon.
Habitat value	Potential of habitat to support wildlife, fish, and plant populations.
Hard elements (cover)	Structural materials and channel features, such as boulders, logs, and undercut banks, that provide protection for fish, including steelhead and Chinook salmon. These hard elements are in contrast to soft elements, such as water features (e.g., turbulence or depth) and vegetation, that also provide protection for fish but are less permanent.
Health	Absence of disease.
Health and vigor indicator	Indicator used to determine the degree of robustness and disease of the foliage, wood, and root crown of planted trees and shrubs in the riparian vegetation and SRA cover mitigation planting areas.
Heat transfer	Amount of solar radiation reaching the stream surface
Height of instrument	Elevation of the line of sight of the level.
Implementation Plan for the Guadalupe River Project Mitigation and Monitoring Plan (IP)	Stand-alone document that provides detailed instructions for collecting, managing, analyzing and evaluating, and reporting on data associated with the environmental monitoring of the Project.
Indicator	Provides information about the condition of ecological functions and habitat values affected by mitigation actions. For example, survival or percentage of cover could be an indicator for riparian vegetation installed as mitigation (U.S. Army Corps of Engineers, 2000).
Instability elements	Category used to described unstable components of banks. See *bank height*, *fracturing, blocking, or slumping*, *mass movement*, and *undercutting*.
Instream cover	Stream habitat features that provide fish with protection from predators or adverse conditions. Includes undercut banks with an undercut width greater than 4 inches; roots, logs, and debris piles greater than 155 inches^2 in surface area; and boulders and rocks greater than 8 inches in diameter (Jones & Stokes Associates, 1997a; Fris and DeHaven, 1993).
Instream cover indicator	Indicator used to measure the proportion of the channel bottom that contains undercut banks; roots, logs, and debris piles; boulders and rocks; and vegetation.
Instream percolation ponds	Ponds created within the stream channel for the purpose of increasing the percolation rate of stream water into the ground.

Invert	River bottom.
Invert stabilization structures	Small weirs placed in the natural river channel to reduce the river grade, trap sediments, and create gravel bars and other in-channel habitat.
Invertebrates	Organisms that lack a spinal column; includes mollusks, crustaceans, insects, starfish, jellyfish, sponges, and many types of worms.
JSATEMP stream temperature model (JSATEMP model)	Water temperature model used to simulate water temperatures in the Guadalupe River and its major upstream tributaries.
Juvenile rearing indicator	Indicator used to quantify the occurrence of juvenile steelhead in the Project area.
Landing pool	Stream area directly above a vertical barrier where a fish jumping the barrier will land.
Launch (a water temperature logger)	To initiate data recording in an automatic water temperature data recording device.
Left bank	When facing downstream, the river bank that is on the left side of the channel.
Line intercept method	Method used to estimate vegetation cover by measuring the distances of the vertical projections of plants on a line transect and expressing those distances as a percentage of the total length of the line transect.
Line transect	Line along which measurements are taken, usually with a taut measuring tape.
Live plants	Stability element that includes perennial herbaceous species, woody shrubs, broadleaf trees, conifer trees, and plant roots that are on or near the surface of the bank and provide substantial binding strength to the bank material.
Local inflow	Accretions and small tributaries that augment flows in the Guadalupe River but are not represented by model segments.
Long wave radiation	Long-wave infrared energy that is emitted from all things, based on their temperatures.
Lookup tables	Matrices used to store data values that are repeated throughout the data tables. For example, plant species abbreviations are used to collect data for several indicators. The lookup table for plant species includes full species name (genus and species), abbreviation, and common name. When the field data are input into GEMS, the species abbreviations can be selected off a drop-down menu or the unique 5-letter code can be checked to ensure that only a valid code is entered. Lookup tables are used to improve efficiency of data entry, perform quality assurance checks, and output reports, where standard abbreviations or full spelling of data values are needed.
Low-flow channel	A narrow channel within a streambed that confines the stream flow during periods of low water volume.
Major storm event	A storm event with an instantaneous flow of 500 cubic feet per second or greater.
Mass movement	Bank failure from landslides and gravity erosion of oversteepened bank slopes.
Measurable objective	Numeric or descriptive goal for an indicator. Used to measure the contribution of the indicator to attainment of the mitigation objective.
Measured shade fraction	Fraction of solar radiation blocked from reaching the water by vegetation, buildings, or topography in each model segment at the time that the aerial photographs were taken. *Shade density* multiplied by *shade coverage*.

Microhabitat	Site-specific habitat contained within larger habitat classifications, such as pocket water, eddy pool, and scour pool.
Mitigation	Actions taken to moderate, reduce, or alleviate the impacts of a proposed activity; includes a) avoiding the impact by not taking a certain action or parts of an action; b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and e) compensating for the impact by replacing or providing substitute resources or environments.
Mitigation objective	Numeric and descriptive goal for the actions that would moderate, reduce, or alleviate Project effects.
Model segment	Segments (shown in lower case) used by the JSATEMP model. In the JSATEMP model, the Guadaluple River system is divided into 39 model segments, which are used for model calculations. Eleven of these segments are affected by Project construction and mitigation. Not a *Segment* of the Project.
Modeled topographic shade fraction	Topographic shade fraction as calculated by the JSATEMP model.
Modeled vegetation shade fraction	Vegetation shade fraction as calculated by the JSATEMP model.
Monitoring year	In most cases, the number of growing seasons since Project or mitigation construction. However, for those mitigation components that had been installed for several years but have not yet been monitored, the monitoring year was adjusted to prevent several more years from elapsing before monitoring was conducted. For example, riparian vegetation sampling plots installed in fall 1994 would be in MY 6 in water year 2001. This monitoring year was problematic because these sampling plots had not been monitored according to the 2000 MMP and (because most riparian vegetation indicators are monitored for the first 5 years following installation and are not monitored again until MY 10) no monitoring would be required for another 4 years. To ensure that data were collected before MY 10, these sampling plots were considered to be in MY 5 in water year 2001.
Monthly average suitability index (for a temperature model segment)	Average of the suitability indices assigned to each hourly water temperature value for the month for a particular model segment.
Monthly thermal suitability indicator	Sum of monthly thermal suitability units for all stream reaches affected by the Project. These stream reaches are represented in the JSATEMP model as model segments 5, 6, and 30–38.
Monthly thermal suitability units (for a temperature model segment)	Monthly average suitability index times the preproject stream surface area.
Monument	Permanent marker on the ground that has a known elevation, latitude, and longitude.
Native	Species locally native to the Guadalupe River watershed.
Native vegetative cover indicator	Indicator used to measure the percentage of ground surface covered by the vertical projection of native vegetative canopy.
Natural barriers	Obstructions in the stream channel formed by natural materials (e.g., gravel, boulders, wood, or vegetation) that impede or delay the upstream or downstream movement of fish. Natural barriers include debris dams, vertical drops in elevation caused by down

	cutting of the stream channel bottom, and shallow riffles caused by an accumulation of substrate.
Natural recruitment	Addition of new plants to a population, either by means of germination from seed or vegetative sprouting.
Natural recruitment indicator	Indicator used to measure natural recruitment in the riparian vegetation and SRA cover mitigation planting areas.
Nonnative	Species not locally native to the Guadalupe River basin.
Noncohesive	Material that does not stick together or is not held together by interparticle cohesion; noncohesive material that easily crumbles apart under force.
Nonnative vegetative cover indicator	Indicator used to measure the percentage of the vegetative canopy that consists of nonnative vegetative cover.
No-project conditions	Estimates of what conditions in the Project area would be if no features of the Project had been constructed.
Notched weir	Constructed channel-spanning structure with a notch in the center of the structure. Used to control water depth in the low-flow channel when stream flows are between 4 and 35 cubic feet per second.
Output tables and figures	Graphics and data tables generated by GEMS and used to prepare tables and figures for annual reports.
Percolation	Movement of water from the stream into the ground.
Photo card	Card on which the sampling plot number and other site identification information is written. This card is placed in the location to be photographed as a means of latter identifying the sampling plot number of the photograph.
Photo point	Fixed location used to take repeated photographs in a fixed direction and from a fixed height.
Pin flags	Small flags on sturdy wire. Used for temporary marking of locations.
Plot stem map	To-scale map of each riparian vegetation sampling plot that shows the relative location, plant identification number, and species of each planted plant.
Pool	Portion of a stream channel where the water is comparatively deep and slow-moving. Pools are typically erosional features and, because they are deeper than adjacent channel reaches, may retain some water even when the rest of the channel is dry.
Pool depth	For the JSATEMP model, average model segment depth at 0 flow.
Pool tailout	Portion of the stream channel where flows are in transition from pool to riffle or run.
Pool width	For the JSATEMP model, average model segment width at 0 flow.
Postproject conditions	Conditions in the Project area after all features of the Project have been constructed. Until all features are constructed, current-postproject conditions are used in the JSATEMP model instead of postproject conditions.
Potentially unstable bank	For the bank stability surveys, a bank that has 75% or more cover but has 1 or more instability elements. However, if bank height is the only instability element present, the bank is considered stable.
Project area	Combined areas that make up the Project: area along the Guadalupe River between Grant Street and Interstate 880, the area along the Guadalupe River between Interstate 880 and Airport Parkway (Reach A mitigation site), and an area of Guadalupe Creek between Masson Dam and Almaden Expressway (Guadalupe Creek mitigation site).
Project partners	Agencies proposing the flood protection components described in this document: the

	U.S. Army Corps of Engineers, Sacramento District, and the Santa Clara Valley Water District.
Project segment	See Segment.
Pyranometer	Meter for measuring solar radiation.
Qualitative assessment	An environmental condition parameter used to appraise the general condition of the entire riparian vegetation and SRA cover mitigation planting areas.
Reach A mitigation site	Area along the Guadalupe River between Airport Parkway and Interstate 880.
Read/write user	User who can update and maintain the contents of the database, as well as generate reports and query the database. Read/write users are responsible for data entry, analysis, and maintaining data quality. The primary read/write user is the Project data manager or other such person designated to update the database. The Project data manager will be responsible for ensuring that the contents of the database are up to date and correct.
Read/write/administer user	User who is the database administrator. In addition to read/write access, the database administrator maintains the functionality of the system, including providing user support, performing custom report and query programming, performing system modifications and maintenance, and making regular backup copies of GEMS.
Read-only user	User who can view, query, and output data. This user group may include members of the Adaptive Management Team, responsible agencies, and project managers. Technically, GEMS is suitable for public access, but the policy and management-support decisions related to public access are beyond the scope of this document.
Rearing habitat	Habitat in which juvenile fish reside before smolting and migrating to the ocean (anadromous species) or maturing and becoming adults (nonanadromous species or life forms). Generally includes adequate cover from high temperatures, solar radiation, predators, and stream velocity.
Rearing habitat diversity indicator	Indicator used to determine the occurrence and average length of channel types (i.e., riffle, run, and pool) in June–September.
Recruitment	See natural recruitment.
Redd	Gravel nest that anadromous fish dig and lay eggs in.
Relative cover	Percentage of the vegetative canopy that consists of a particular vegetation category or plant species.
Remedial action	Action taken to correct failing components of the mitigation, such that these components may meet measurable objectives in the future.
Riffle	Shallow reach with swiftly flowing turbulent water with some partially exposed substrate, usually cobble or gravel. Riffles are depositional features, are important food-producing areas, and provide spawning habitat for steelhead and Chinook salmon.
Right bank	When facing downstream, the river bank that is on the right side of the channel.
Riparian	Pertaining to the banks of a flowing body of water (e.g., rivers, streams) and the plant and animal communities along such bodies of water.
Riparian vegetation	Vegetation typically growing adjacent to a natural watercourse.
Riparian vegetation monitoring component	Umbrella term for the indicators related to riparian vegetation: survival, health and vigor, natural recruitment, native vegetative cover, nonnative vegetative cover, tree height, and tree basal area indicators.
Rock	Stability element consisting of boulders, bedrock, and cobble/boulder aggregates that

	are combined to form a stable mass.
Root crown	Base of the main stem at ground surface (root crown as defined here may not always represent the root crown as defined anatomically).
Run	Channel segment characterized by uniform depth and comparatively swift stream flow with little or no surface turbulence evident. Intermediate between a riffle and a pool.
Salmonid	Large family of fish whose members have 3 upturned vertebrae. Includes steelhead and Chinook salmon.
SCVWD stream flow data	Stream flow data posted by the Santa Clara Valley Water District at http://alert.scvwd.dst.ca.us/alertstr.html.
Secchi tube	Device used to measure water clarity. Similar to a Secchi disk used in limnology.
Segment	Segment of the Project. The Project is divided into Segments 1, 2, and 3. Segment 3 is further subdivided into Segments 3A, B, and C. Not a *model segment*.
Segment 1	Area along the Guadalupe River between Interstate 880 and Hedding Street.
Segment 2	Area along the Guadalupe River between Hedding Street and Coleman Avenue.
Segment 3	Area along the Guadalupe River from Coleman Avenue to Park Avenue and from Woz Way to Park Avenue.
Segment 3A	Portion of Segment 3 between Coleman Avenue and New Julian Street.
Segment 3B	Portion of Segment 3 between New Julian Street and Park Avenue.
Segment 3C	Portion of Segment 3 between Woz Way and Grant Street.
Shade coverage	In the JSATEMP model, fraction of a model segment shaded by vegetation, topography, or buildings (as shown in the aerial photographs). These values do not include the effect of shade density. *Shaded stream area* divided by *total segment area.*
Shade density	In the JSATEMP model, average fraction of light screened by trees when the trees have full foliage, currently approximately 0.9 in Segments 1–3, Reach A, and Guadalupe Creek.
Shade density measurement	*Solar radiation measured in a shaded* area divided by s*olar radiation measured in full sun.*
Shade factor	In the JSATEMP model, *vegetated fraction* multiplied by *shade density*. The shade factor is always between 0 and 1.0.
Shaded riverine aquatic (SRA) cover	The unique, nearshore aquatic area at the interface between a river or stream and adjacent woody riparian habitat. Key attributes of this aquatic area include the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water and the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, often substantial detritus, and variable water velocities, depths, and flows (after Fris and Dehaven 1994).
Shaded riverine aquatic (SRA) cover monitoring component	Umbrella term for the indicators related to SRA cover: survival, health and vigor, natural recruitment, nonnative vegetative cover, shaded stream surface, bank stability, instream cover, and channel bottom stability indicators.
Shaded stream area	Stream area shaded by vegetation, buildings, or topography in each model segment.
Shaded stream surface indicator	Indicator used to measure the percentage of the total stream surface area shaded by trees and shrubs during midday in August or September.

Shallow riffles	Channel where water is less than 1 foot deep.
Short-term thermal suitability index (or units)	Value used as the indicator for short-term thermal suitability. It is the area of postproject stream surface area that is considered suitable divided by the stream surface area that would have been considered suitable if the Project had not been built. The value is presented as a percentage. Each life stage of fish present in the river has a suitability index value. These values depend on flow and meteorology for current conditions.
Short-term thermal suitability indicator	Indicator used to determine the surface area of stream that provides suitable water temperatures in April–October.
Shuttle	Device used to transfer data between water temperature loggers and a computer.
Soil moisture	Volume of water available to plants as a proportion of total soil volume.
Soil texture	Relative proportion of sand, silt, and clay in soil.
Solar coefficient	In the JSATEMP model, the fraction of the solar radiation reaching the water surface that is estimated to be absorbed by the water.
Solar radiation	Shortwave (0.3–3 : m) energy from the sun.
Spawn	To lay eggs, especially by fish.
Spawning gravel	Streambed gravel used by fish as a place to lay eggs and fertilize them. Some species (e.g., cold water anadromous fish such as steelhead and Chinook salmon) require a specific size, depth, and extent of gravel in a streambed to spawn successfully. Spawning habitat is critical to the survival of fish species in an area.
Spawning gravel abundance indicator	Indicator used to measure the area of gravel-size particles available to anadromous fish for spawning.
Spawning gravel quality indicator	Indicator used to measure the size of gravel particles in spawning gravel beds.
SRA cover sampling plots	Twenty-four sampling plots located in Segments 1, 2, and 3; Reach A; and Guadalupe Creek used to asses SRA cover. Sampling plots 1–12 are located along the Guadalupe River and are numbered sequentially, starting at the downstream end of Reach A (figure E-1, pages 1–19, in appendix E). Sampling plots 13–24 are located along Guadalupe Creek and are numbered sequentially, starting at the downstream end (figure E-1, pages 20–27, in appendix E).
Stability elements	Category used in the channel bottom stability surveys to described stable components of banks. See *live plants*, *rock*, *downed wood*, *erosion-resistant soil*.
Stable bank	For the channel bottom stability surveys, a bank that has 75% or more cover of living plants and/or other stability components that are not easily eroded and has no instability elements (U.S. Department of Agriculture Forest Service 1998).
Stable ground cover	Stability element that includes rooted trees, shrubs, herbaceous plants, and naturally occurring rocky substrates.
Stadia rod	Telescoping pole with plainly marked heights, in feet.
Staging pool	Pool directly downstream of a vertical drop or vertical barrier. Generally, it is a plunge pool caused by water falling vertically from the top of a vertical drop or barrier. The ability of a fish to successfully jump over a vertical barrier is directly related to the depth of the staging pool.
Station	Linear distance on tape along a survey transect.
Stream channel geometry	An environmental condition parameter defined by depth and width of the stream, used in the JSATEMP model to assess water temperature. Daily temperature variation in

	the stream is directly influenced by the water volume and stream surface area.
Stream flow	Volume of water in a stream or river passing a given point per unit of time. Typically estimated either indirectly by a stream gage or directly in the field by taking water depth, width, and velocity measurements at discrete intervals along a cross section.
Stream gage	A device for measuring stream elevation, which can be used to estimate flow.
Substrate	Materials (mineral and/or organic) that compose the stream bed.
Suitability index (SI)	A unitless number between 0 and 1 that measures how suitable the habitat is for a particular species or life stage of animal, including fish; 0 indicates no suitability and 1 indicates optimal suitability. Suitability indices can apply to any habitat variable, including water temperature, instream cover, and quality of spawning gravel.
Suitable temperatures (for the short-term thermal suitability index)	Monthly median temperatures that correspond to a suitability index greater than or equal to 0.5.
Survival indicator	Indicator used to measure survival of planted trees and shrubs in the first 3 years after planting. If the average health and vigor for a tree or shrub is less than “fair” (i.e., score less than 2), the plant is assumed to be dead.
Terrace	Abandoned floodplain that is now outside and above the active floodplain and is rarely overtopped during floods.
Terrestrial vegetation shade	The stream surface shaded by vegetation growing on the stream banks or at the water’s edge.
Time-series data	Data that occur at regular intervals over time, such as hourly water temperature data.
Top of bank	The break in slope between the steep-sloping bank and low-sloping or horizontal terrace surface above any lower floodplain surfaces.
Topographic shade	Shade on the stream surface that is created by the stream banks.
Topographic shade fraction	Fraction of maximum possible solar radiation that is blocked from reaching the water surface of a model segment by topographic shade at a particular time
Top-setting wading rod	Rod that has a device for easily placing a velocity meter sensor at 0.2, 0.6, or 0.8 of the depth of the water.
Total monthly suitability units	Sum of all the habitat units for model segments 5, 6, and 30–39 (i.e., the monthly thermal suitability indicator)
Total segment area	
Total suitable area	Surface area in model segments 5, 6, and 30–39 that has water temperatures that are considered suitable (see *suitable temperatures*).
Tree basal area	Area of the horizontal section of a tree measured at breast height (i.e., 4.5 feet above the ground surface).
Tree basal area indicator	Indicator used to measure the total area of native tree species’ stems at breast height (i.e., 4.5 feet above the ground surface) per unit area of ground surface.
Tree height indicator	Indicator used to measure the range of native tree species’ heights in the riparian vegetation mitigation planting area.
Tree structure	Branching architecture of a tree.

Undercut bank	Section of bank that has been eroded at its base, because of stream flows, and overhangs the channel.
Undercutting	Instability element consisting of frequent or continuous scour and significant to severe undercut bank.
Unstable bank	For the bank stability surveys, a bank that has less than 75% cover and 1 or more instability elements. Unstable banks are often bare or nearly bare banks composed of particle sizes too small or noncohesive to resist erosion at high flows (U.S. Department of Agriculture Forest Service 1998).
Vegetated fraction	For the JSATEMP model, the fraction of the model segment (for each bank) that is lined with trees.
Vegetation category	One of the following categories of vegetation: native trees, nonnative trees, native shrubs, nonnative shrubs.
Vegetation density	Number of trees and shrubs per unit area.
Vegetation shade fraction	Fraction of maximum possible solar radiation that is blocked from reaching the water surface of a model segment by vegetation at a particular time (*shade coverage* times *shade density*). This value depends on shadow position and length.
Vegetative cover	Percentage of ground surface covered by a vertical projection of aerial plant parts.
Vegetative sprouts	Stems sprouting from roots or the base of a trunk or stem.
Velocity meter	Device used for measuring the speed of water.
Vertical	For the JSATEMP model, vertical lines within a cross section of the stream channel that represent where depth was measured.
Vertical barrier	Barrier to fish passage caused by a Project feature, such as a weir. Several factors must be assessed to identify a vertical barrier: barrier height, horizontal distance the fish must jump, staging pool depth, and landing pool depth.
Vertical barrier indicator	Indicator used to identify potential fish barriers, based on vertical height requirements necessary for passage of adult anadromous fish through the Project area. Several factors must be assessed to identify a vertical barrier: barrier height, horizontal distance the fish must jump, staging pool depth, and landing pool depth.
Vigor	Robustness of a plant.
Visual estimation method	Semiquantitative means of estimating vegetative cover by direct observation.
Wading staff	Rod to assist a wading person with balance.
Water logger case	Case to protect water temperature loggers.
Water's edge	Edge of the stream where the stream bank and water intersect.
Water temperature monitoring component	Umbrella term for the indicators and environmental condition parameters that are related to water temperature: monthly thermal suitability and short-term suitability indicators and measured water temperature, solar heat transfer, stream channel geometry, and stream flow environmental condition parameters.
Water temperature logger	Device that measures water temperature and records the measurements at specified intervals. Onset's StowAway logger is an example.
Weir	Dam, wall, screen, or other structure in a waterway used to store, divert, screen, or measure water.
Wetted channel	Portion of the channel from water's edge to water's edge.

Wetted perimeter	Distance along the bottom and sides of a cross section in a body of water in contact with water that is roughly equal to the width plus twice the mean depth.
Year 0	Time immediately following Project construction. Used to indicate monitoring activities that are to be conducted immediately after Project construction (within the same season) or in 2001 to establish baseline conditions and background data for certain SRA cover and water temperature indicators.

References

Bates, R. L. and J. J. Jackson. 1984. *Dictionary of geological terms*. 3rd edition. Prepared under the direction of the American Geological Institute. Garden City, NY: Anchor Press/Doubleday.

Fris, M. B., and R. W. DeHaven. 1993. *A community-based habitat suitability index model for shaded riverine aquatic cover, selected reaches of the Sacramento River system.* Draft. Sacramento, CA: U.S. Fish and Wildlife Service.

Jones & Stokes Associates, Inc. 1997. *HEP analysis of aquatic resources for downtown Guadalupe River flood control project.* February 21. (JSA 95-116.) Final. Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA.

U.S. Army Corps of Engineers. 2001a. *Integrated general re-evaluation report/environmental impact report/supplemental environmental impact statement for proposed modifications to the Guadalupe River project, downtown San Jose, California.* Final. February. Volume 2b (*Guadalupe River flood control project, downtown San Jose, California, mitigation and monitoring plan*). Sacramento, CA. Prepared by U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA; Santa Clara Valley Water District, San Jose, CA; and Jones & Stokes, Sacramento, CA.

U.S. Department of Agriculture Forest Service. 1998. *Stream condition inventory guidebook.* Version 4.0. Vallejo, CA: Pacific Southwest Region.

Appendix B

Relationship Diagrams of Primary Data and Metadata Tables for Indicators/Environmental Condition Parameters

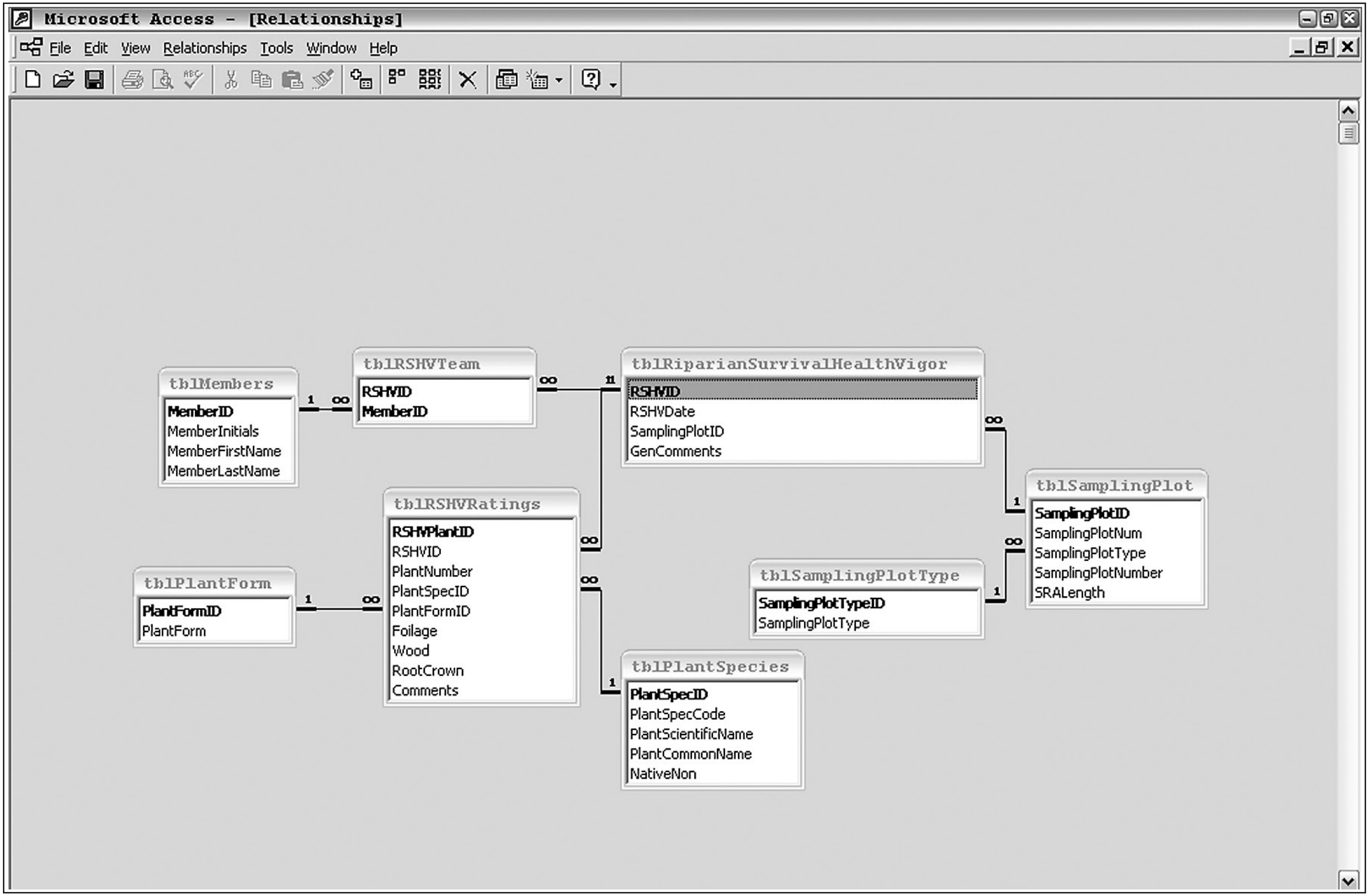

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Figure B-1
Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Health and Vigor and Survival Indicators

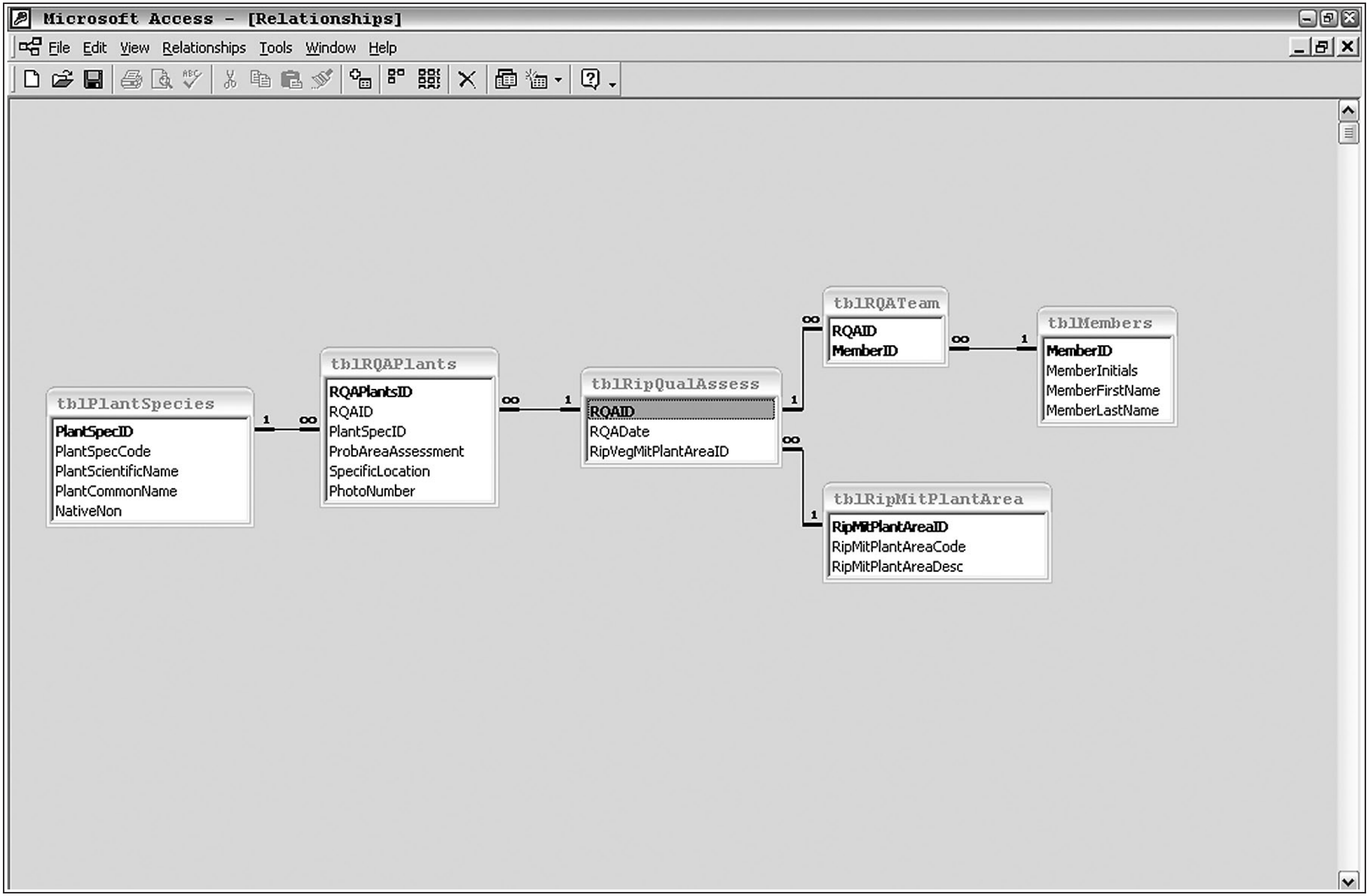

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Figure B-2
Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Qualitative Assessment Environmental Condition Parameter

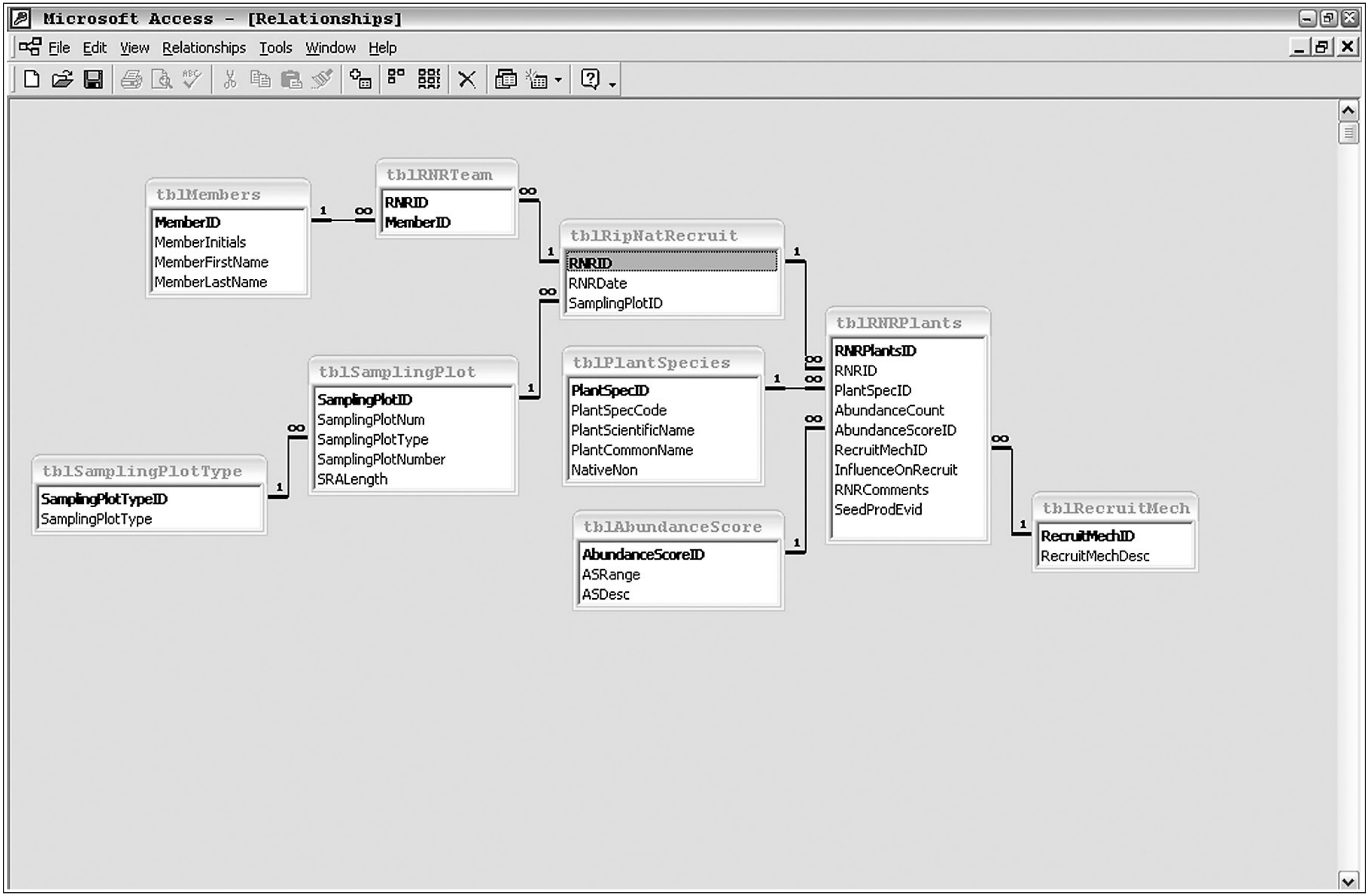

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Figure B-3
Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Natural Recruitment Indicator

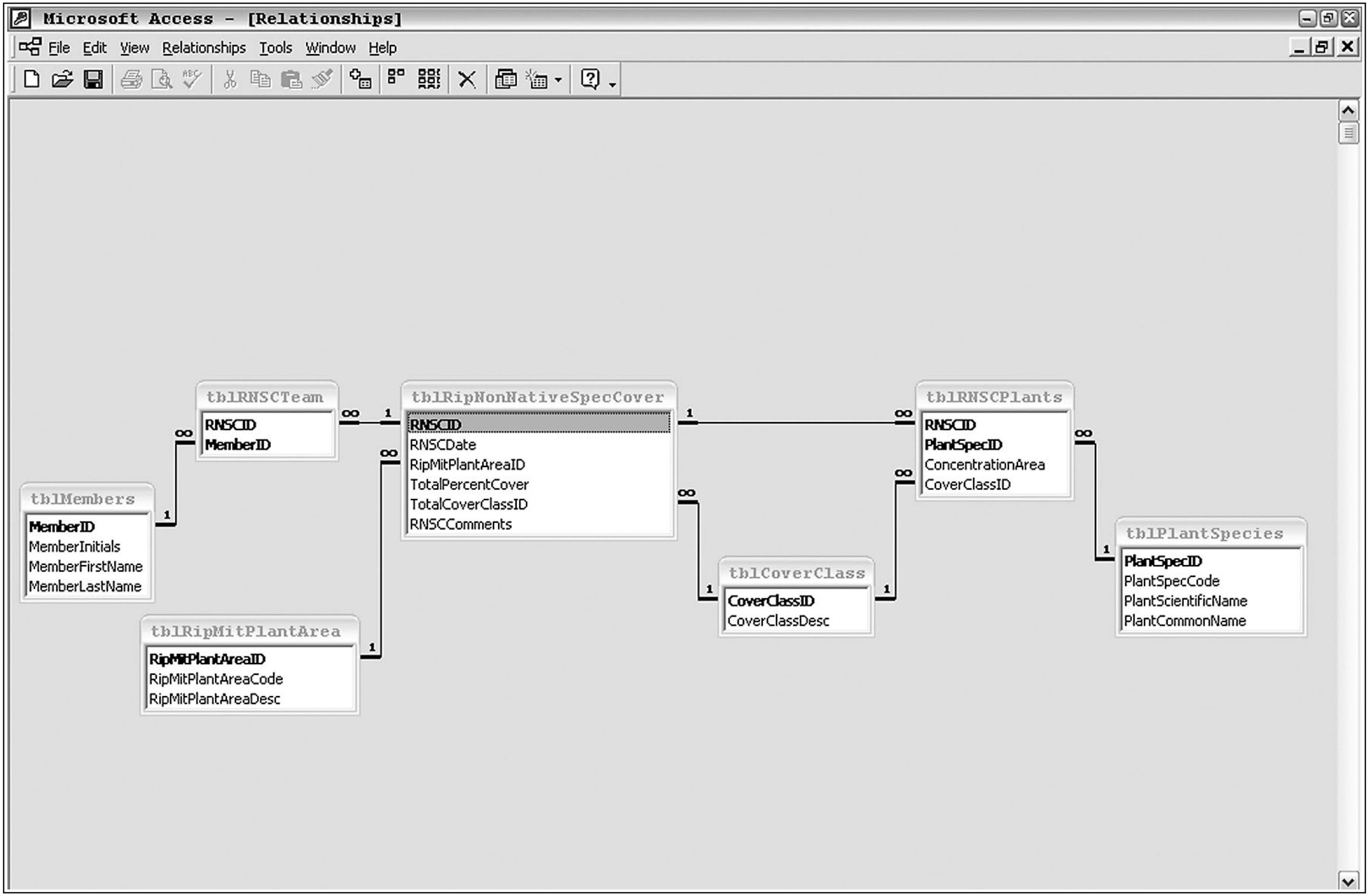

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Figure B-4a
Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Nonnative Vegetative Cover Indicator

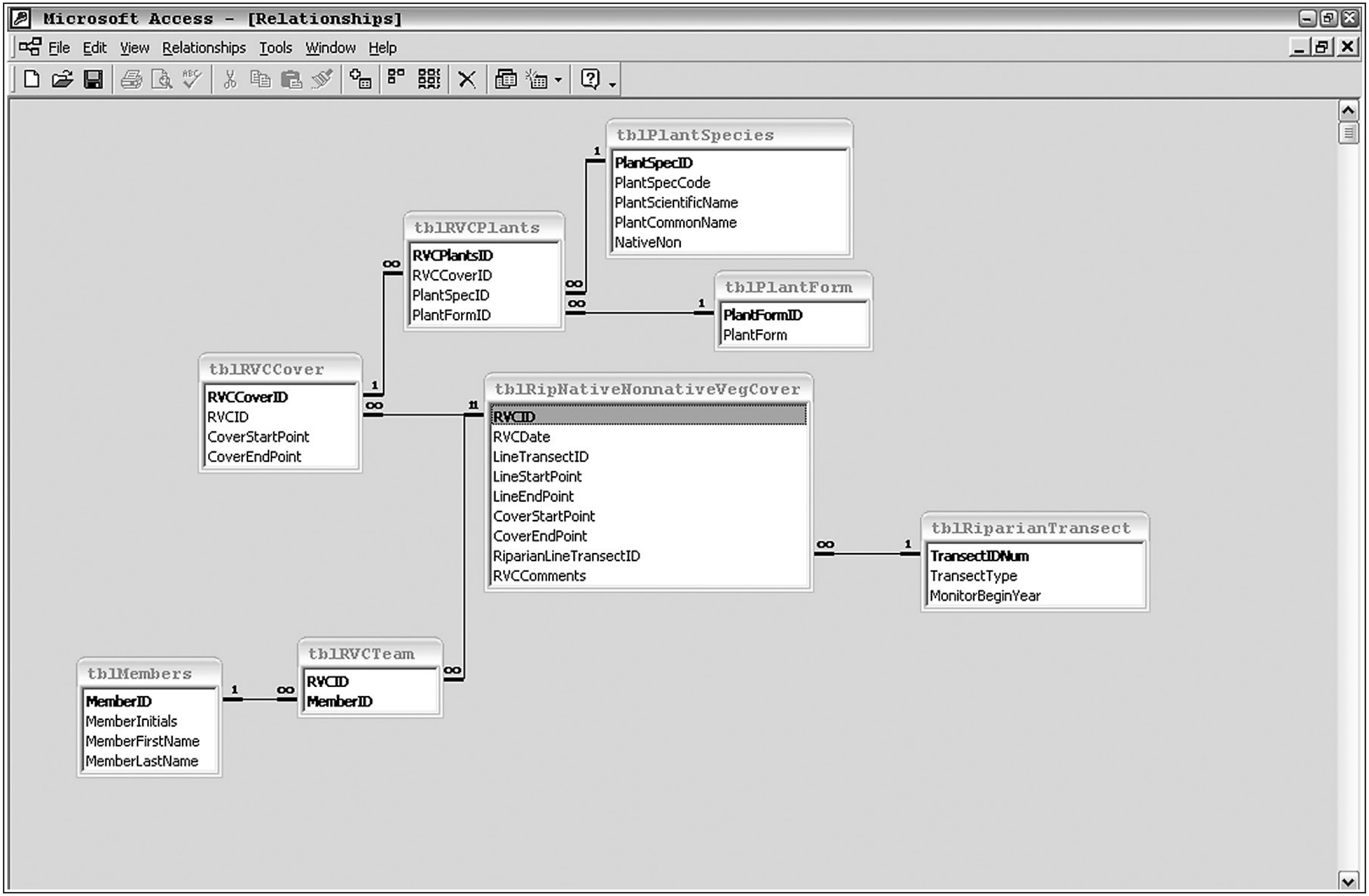

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Figure B-4b
Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Native Vegetative Cover Indicator

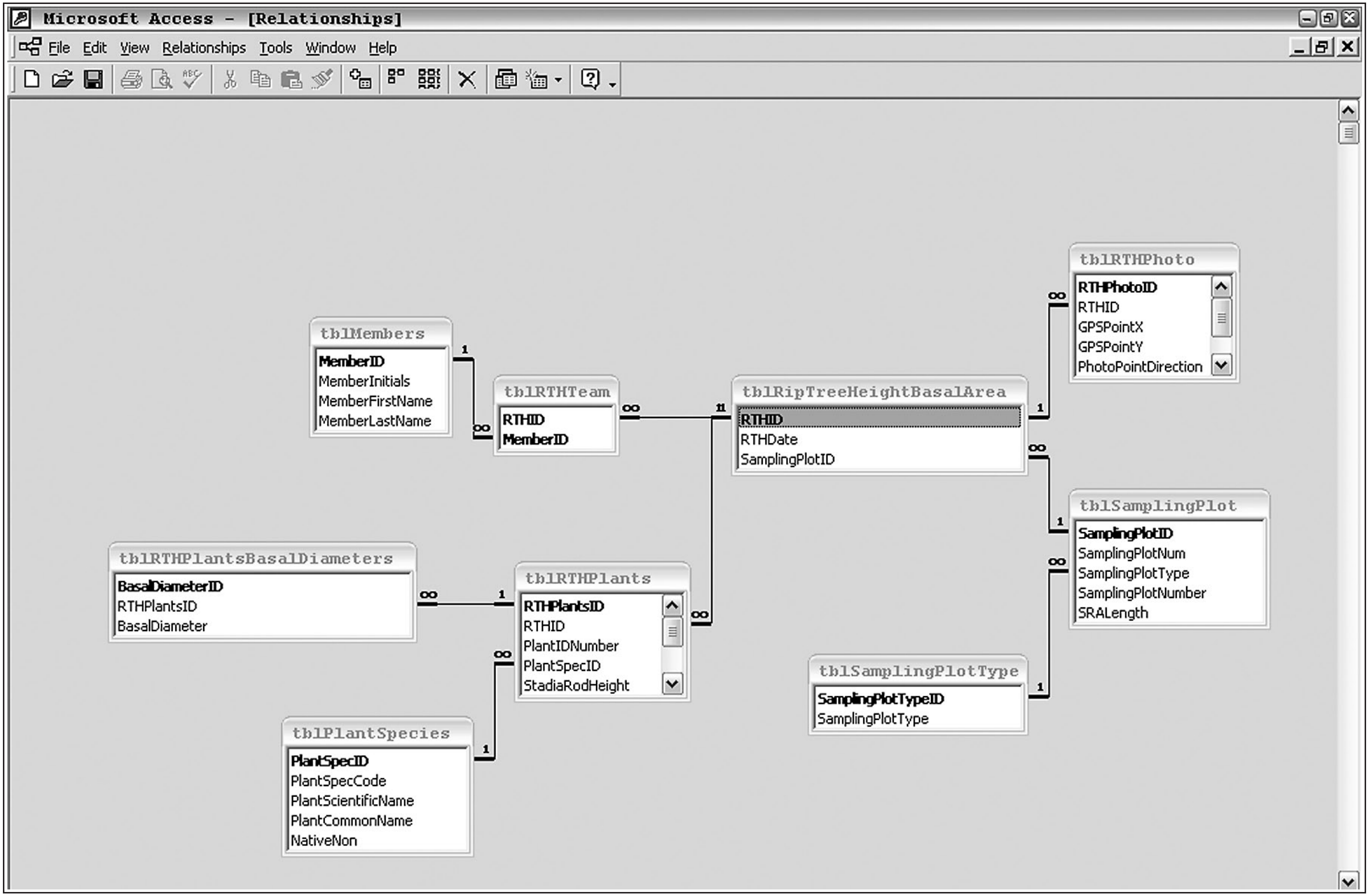

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Figure B-5

Riparian Vegetation — Relationship Diagram of Primary Data and Metadata Tables for the Tree Height and Tree Basal Area Indicators

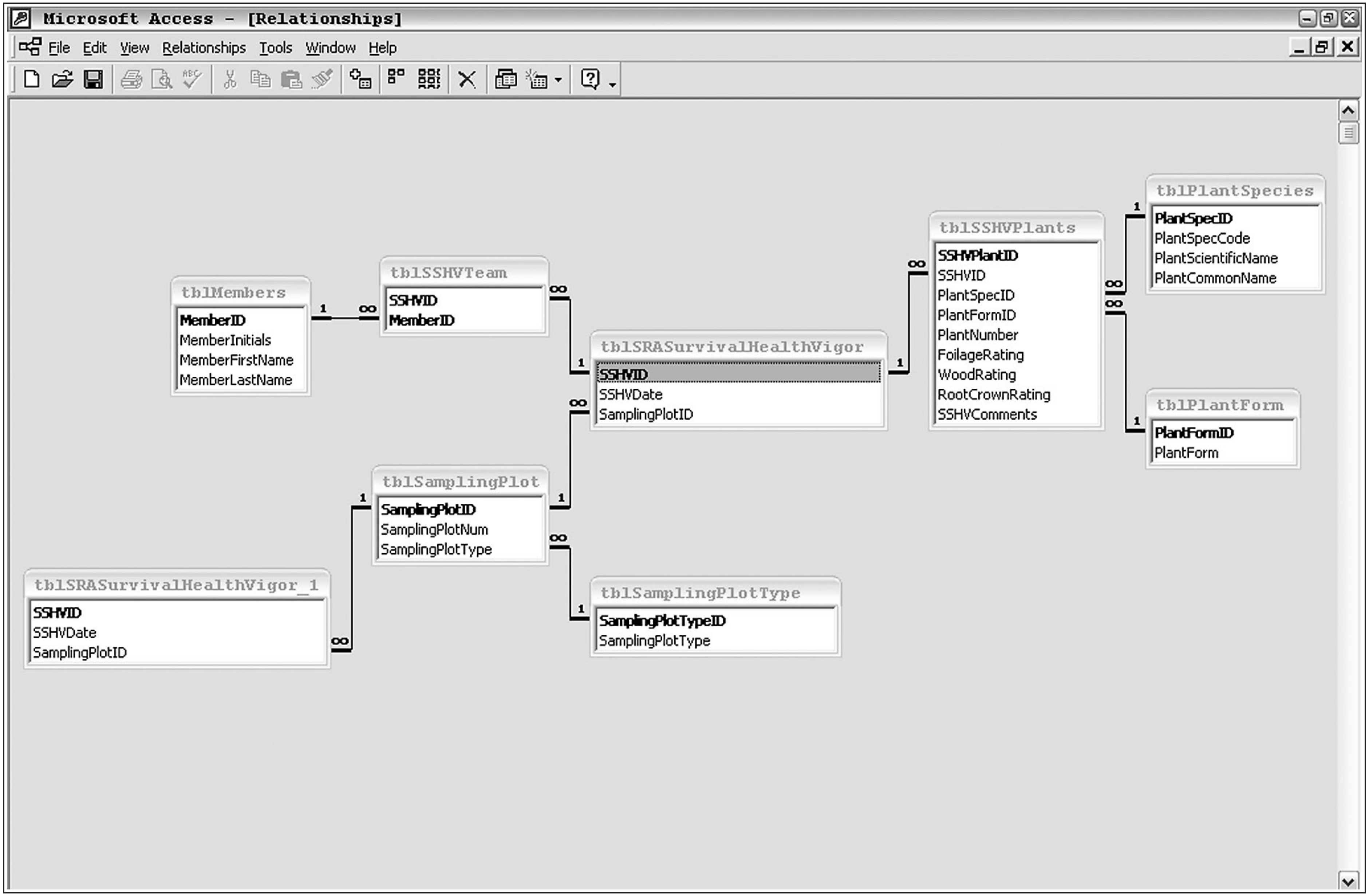

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Figure B-6
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Survival and Health and Vigor Indicators

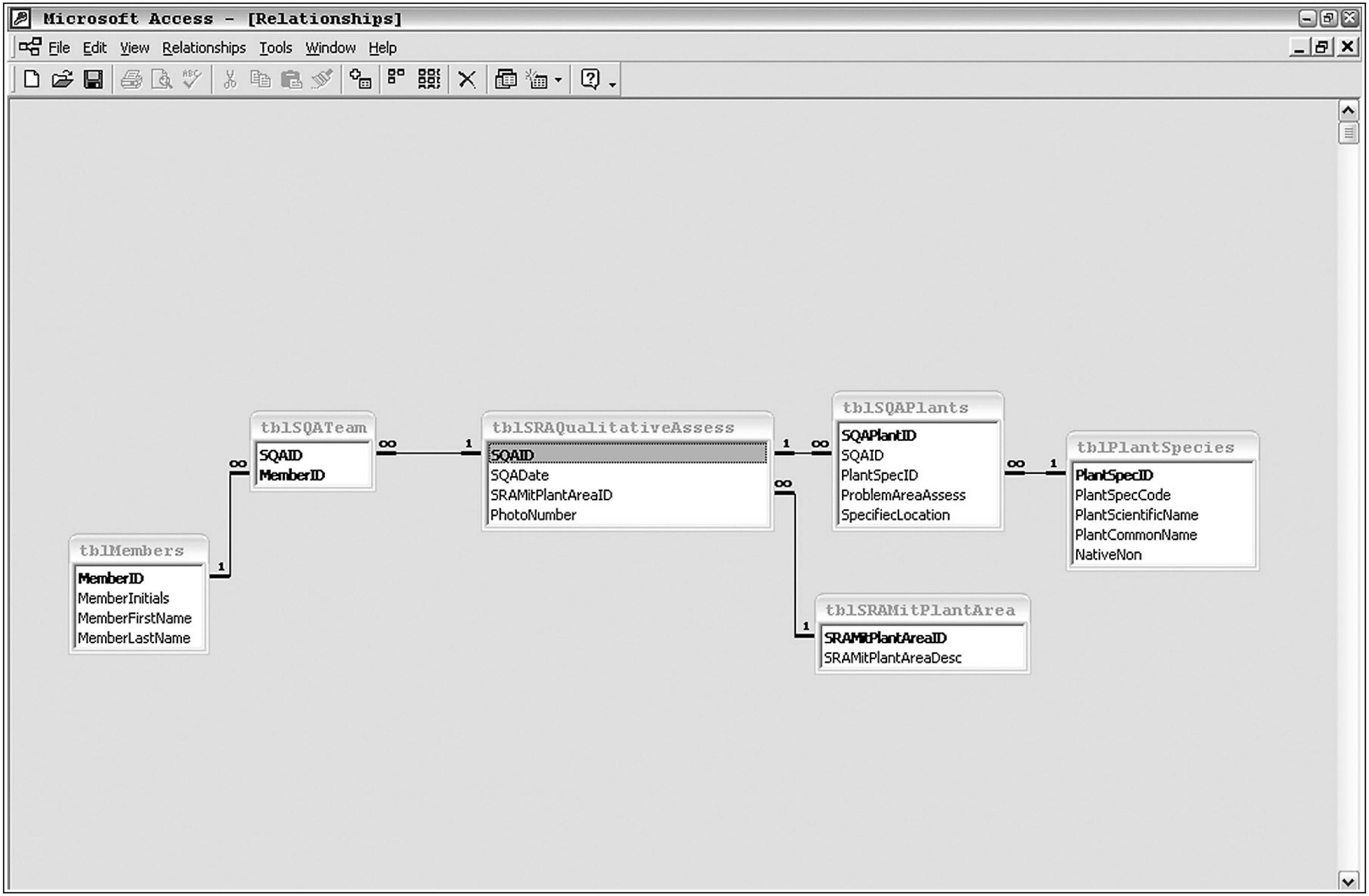

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Figure B-7
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Qualitative Assessment Environmental Condition Parameter

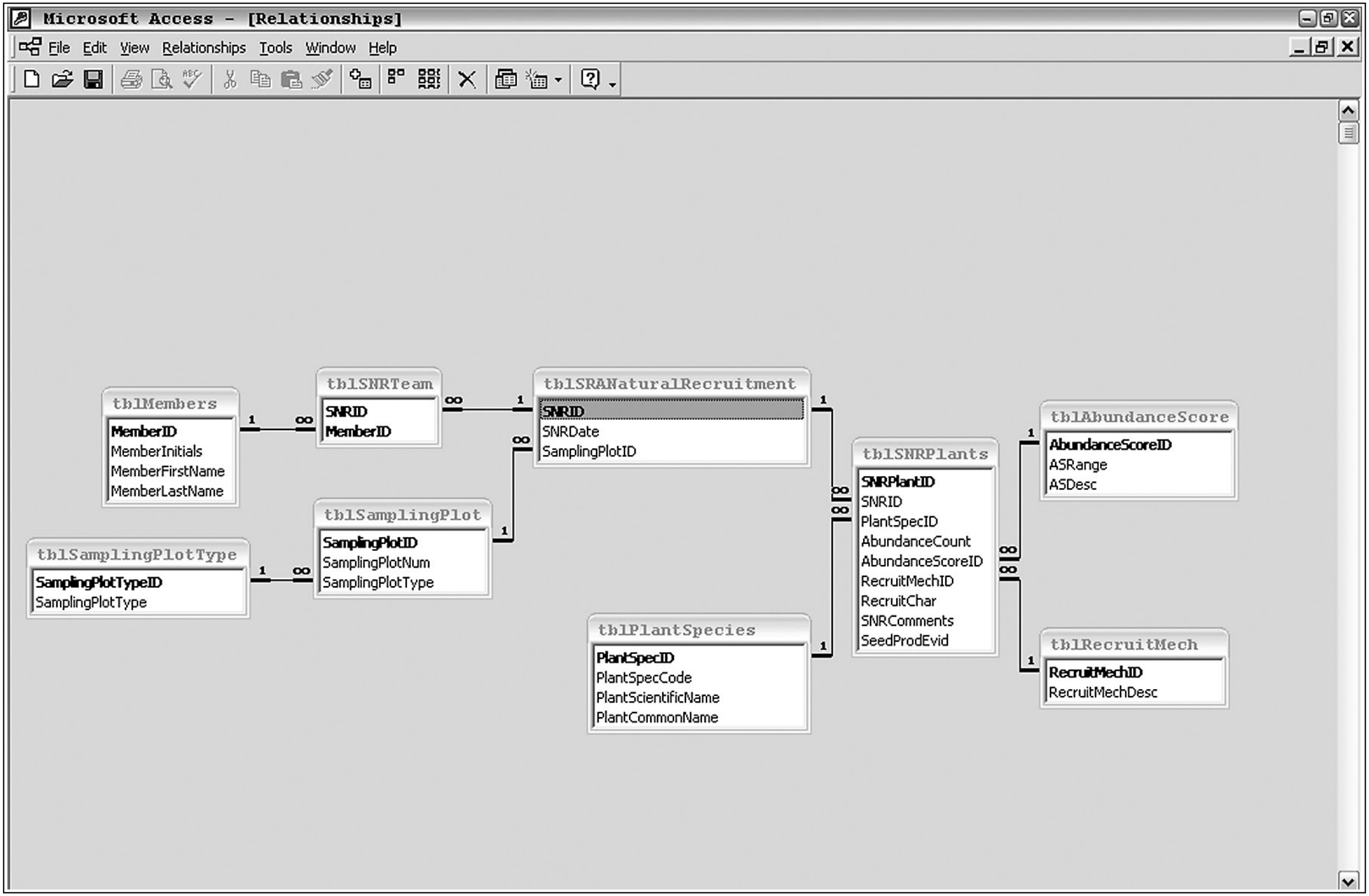

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Figure B-8
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Natural Recruitment Indicator

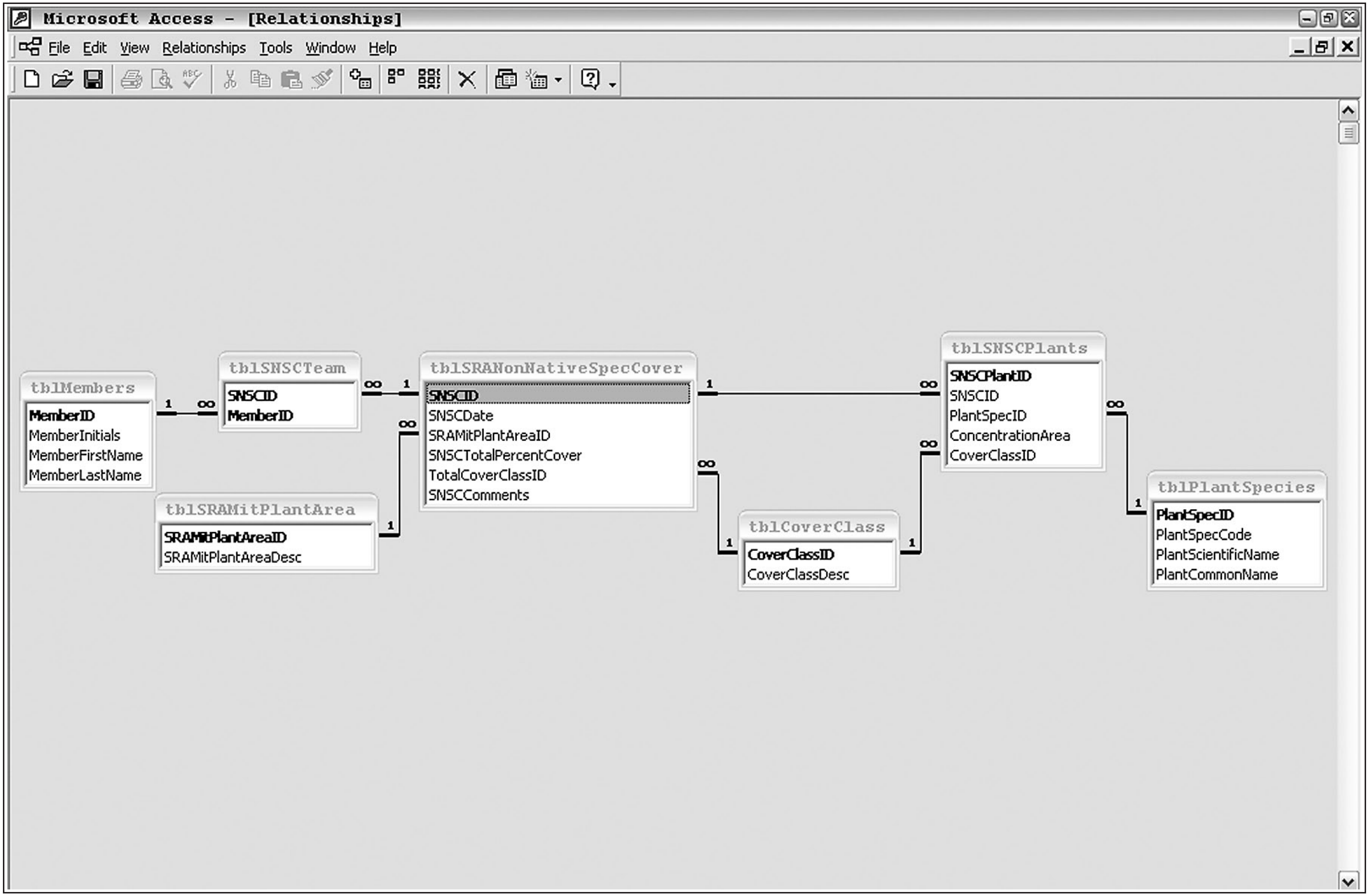

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Figure B-9
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Nonnative Vegetative Cover Indicator

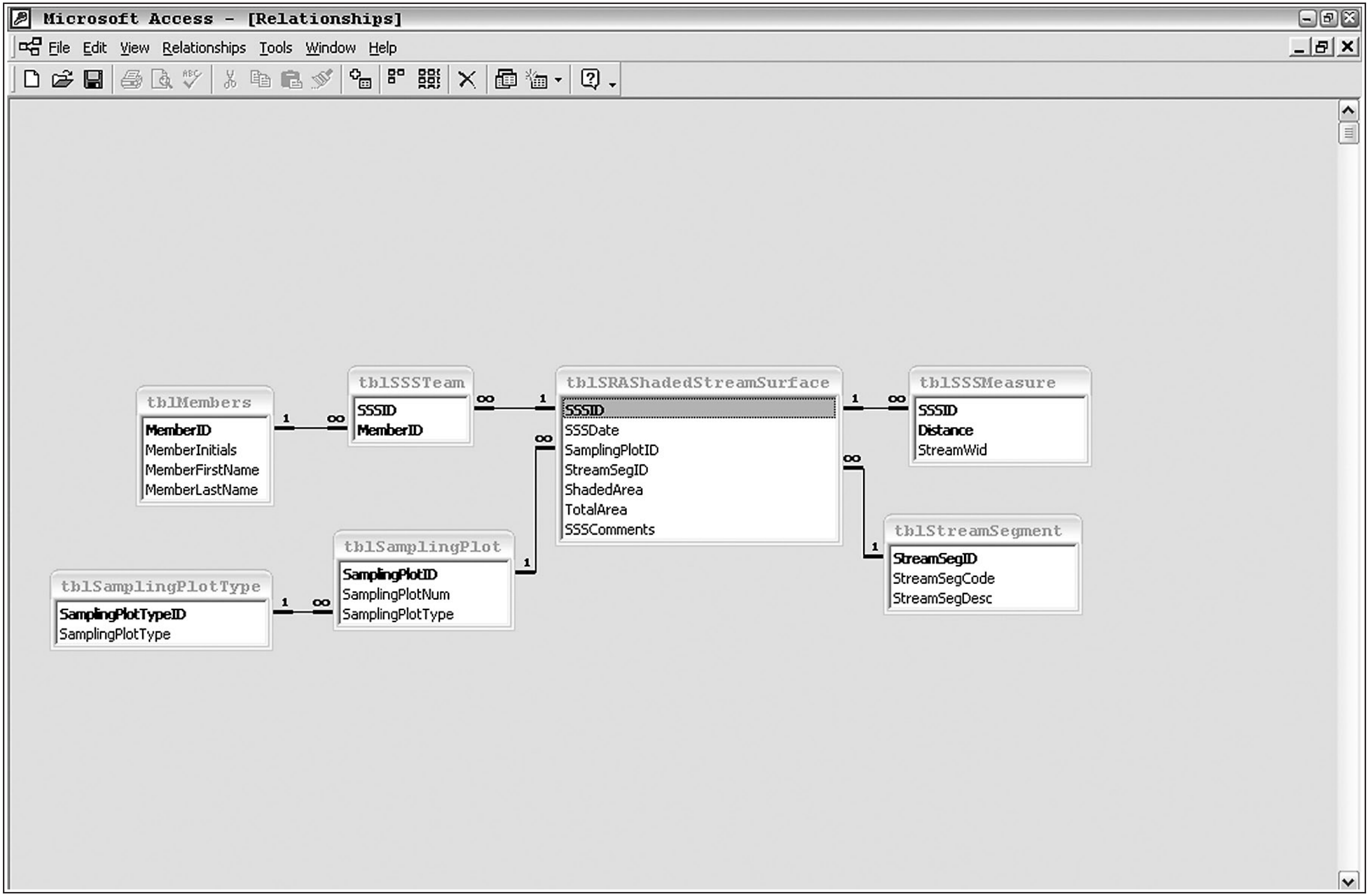

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Figure B-10
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Shaded Stream Surface Indicator

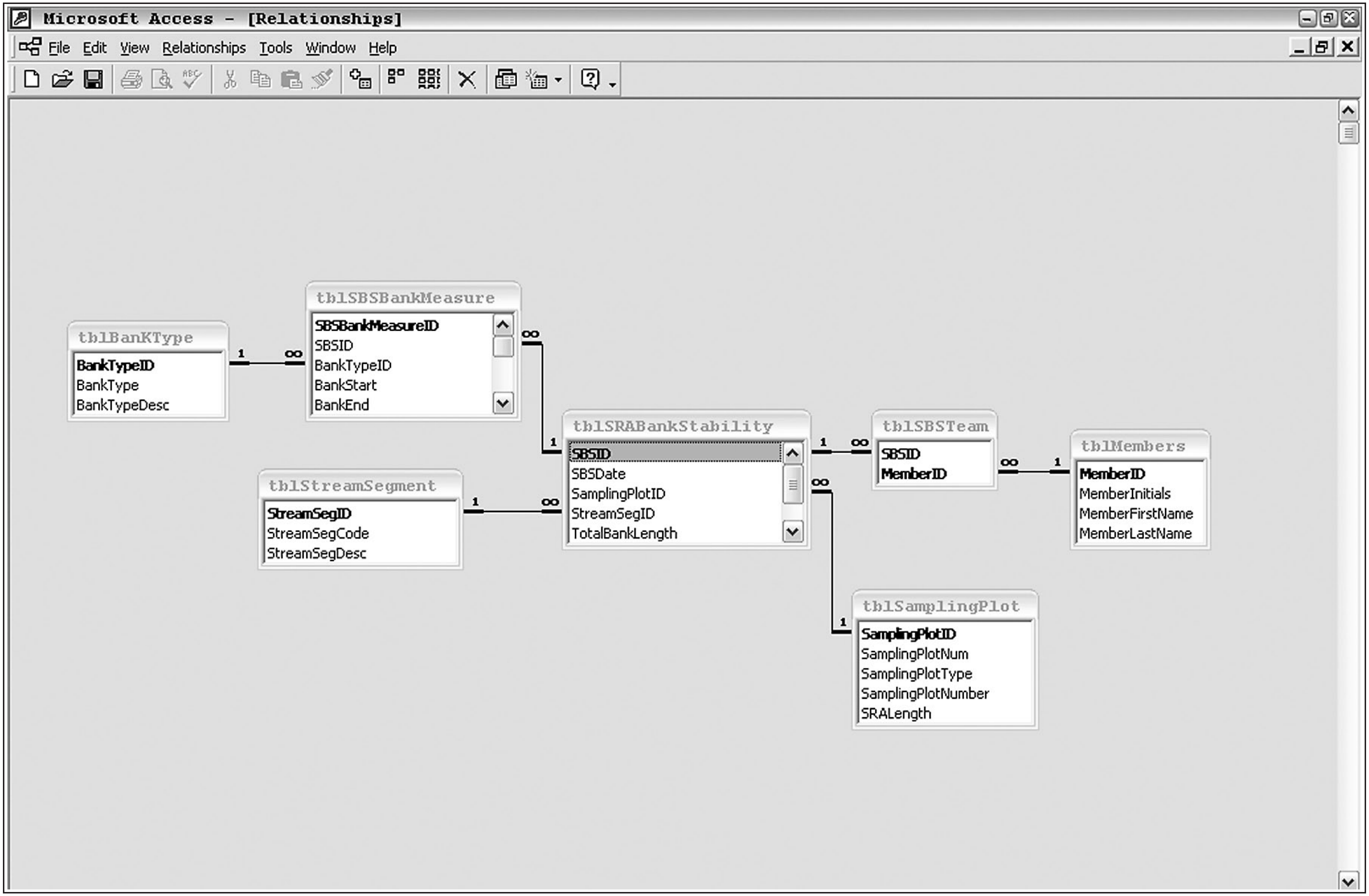

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Figure B-11
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Bank Stability Indicator

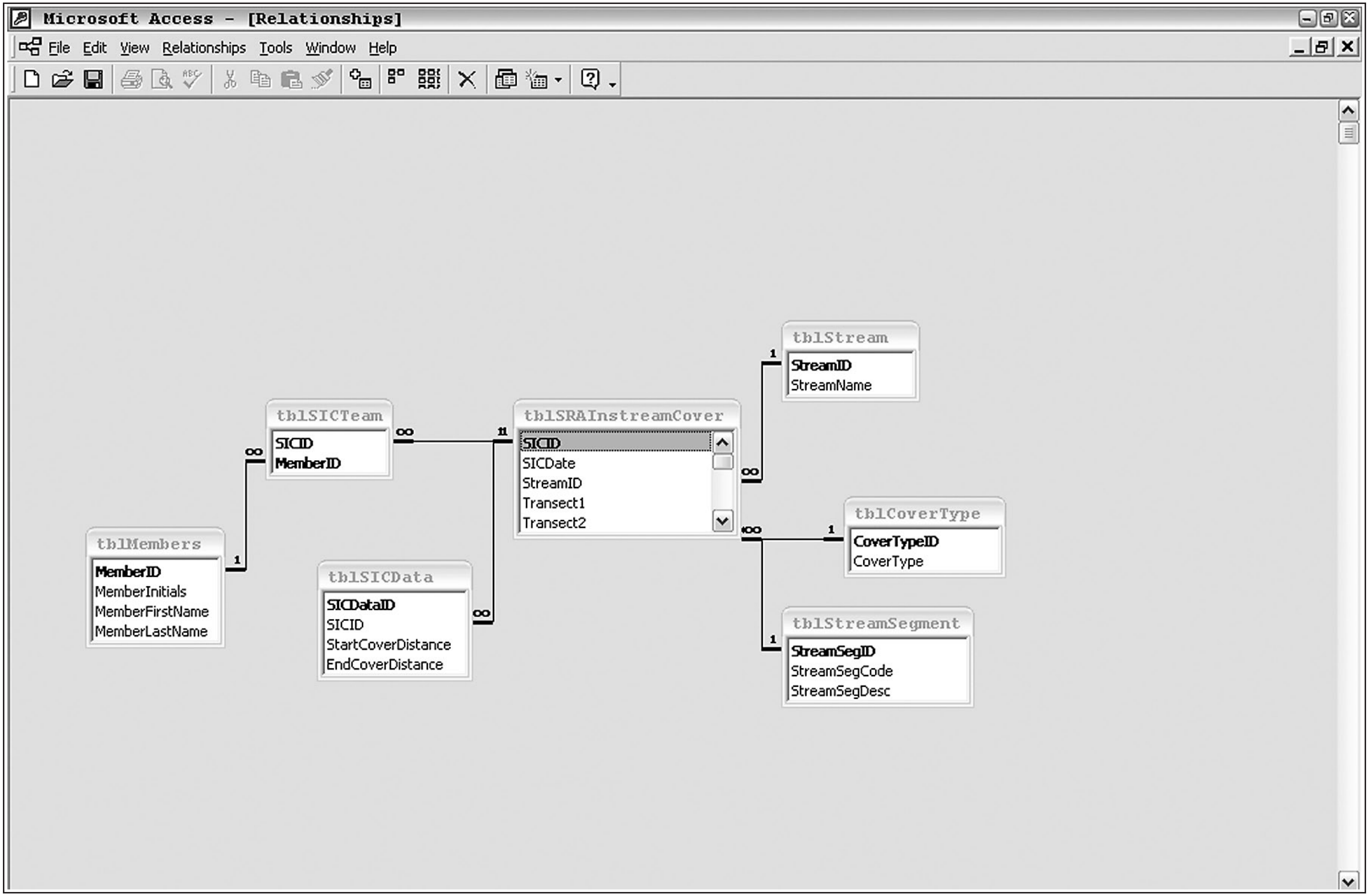

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Figure B-12
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Instream Cover Indicator

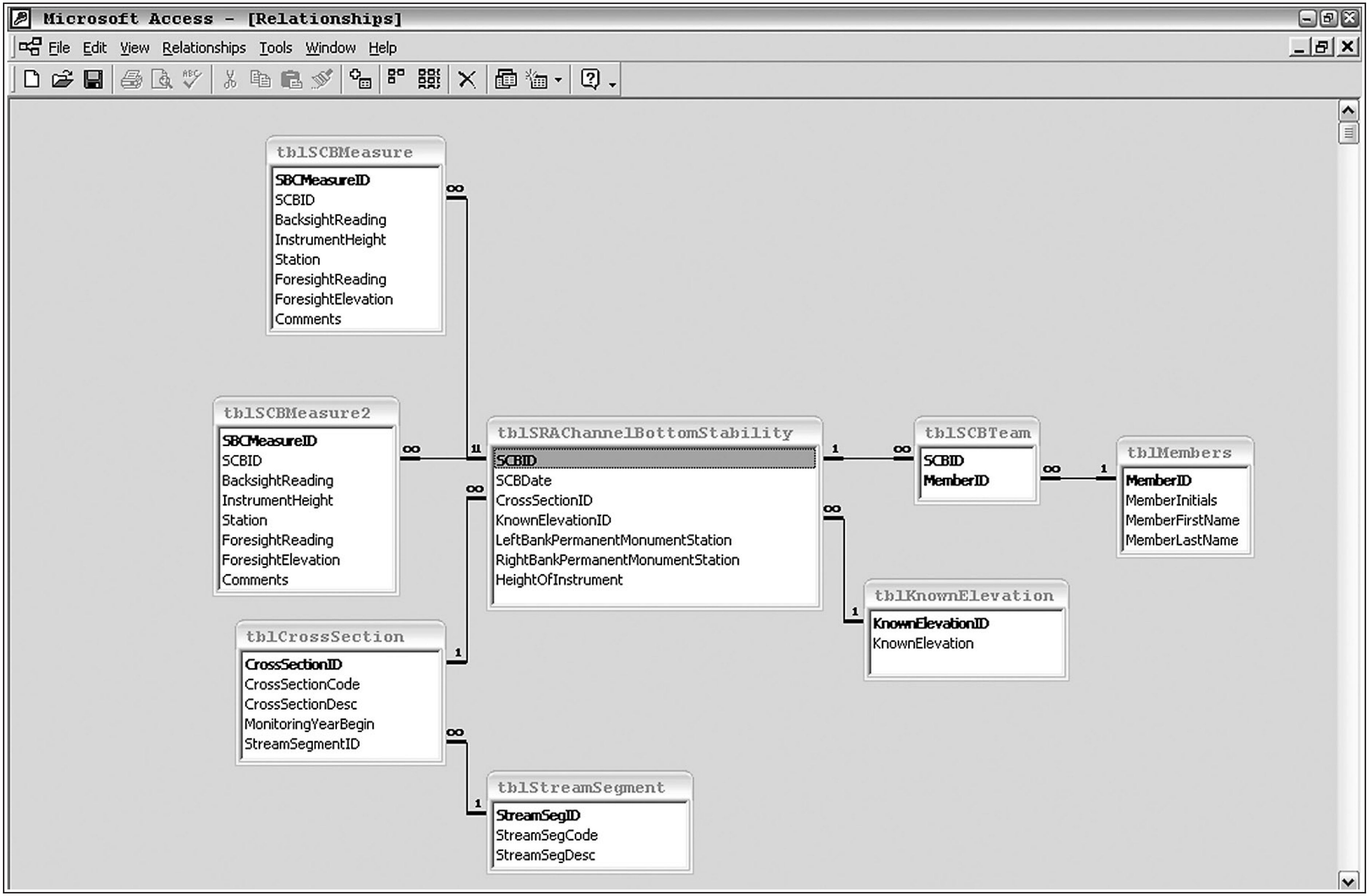

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Figure B-13
SRA Cover — Relationship Diagram of Primary Data and Metadata Tables for the Channel Bottom Stability Indicator

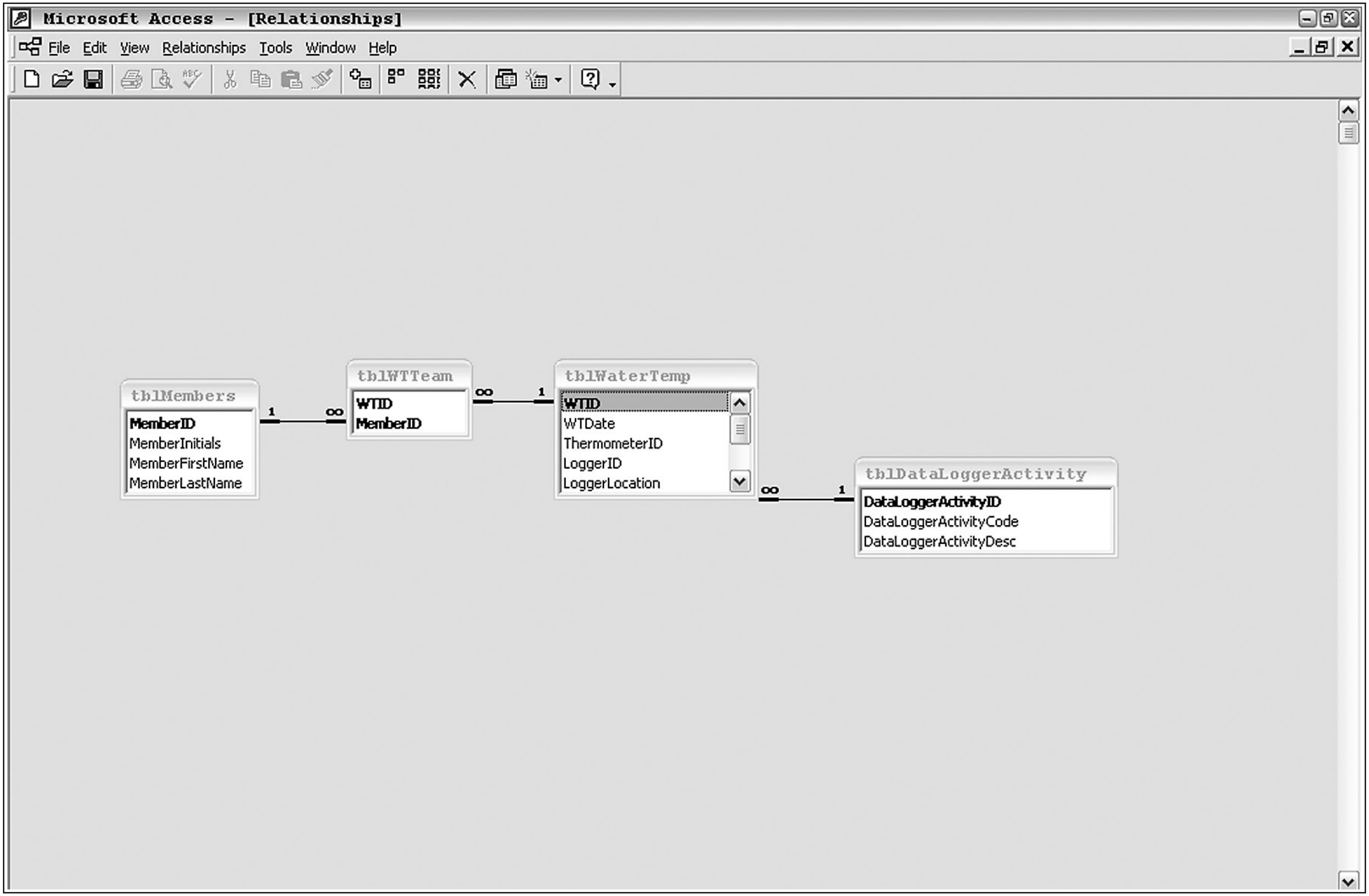

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Figure B-14
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Measured Water Temperature Environmental Condition Parameter

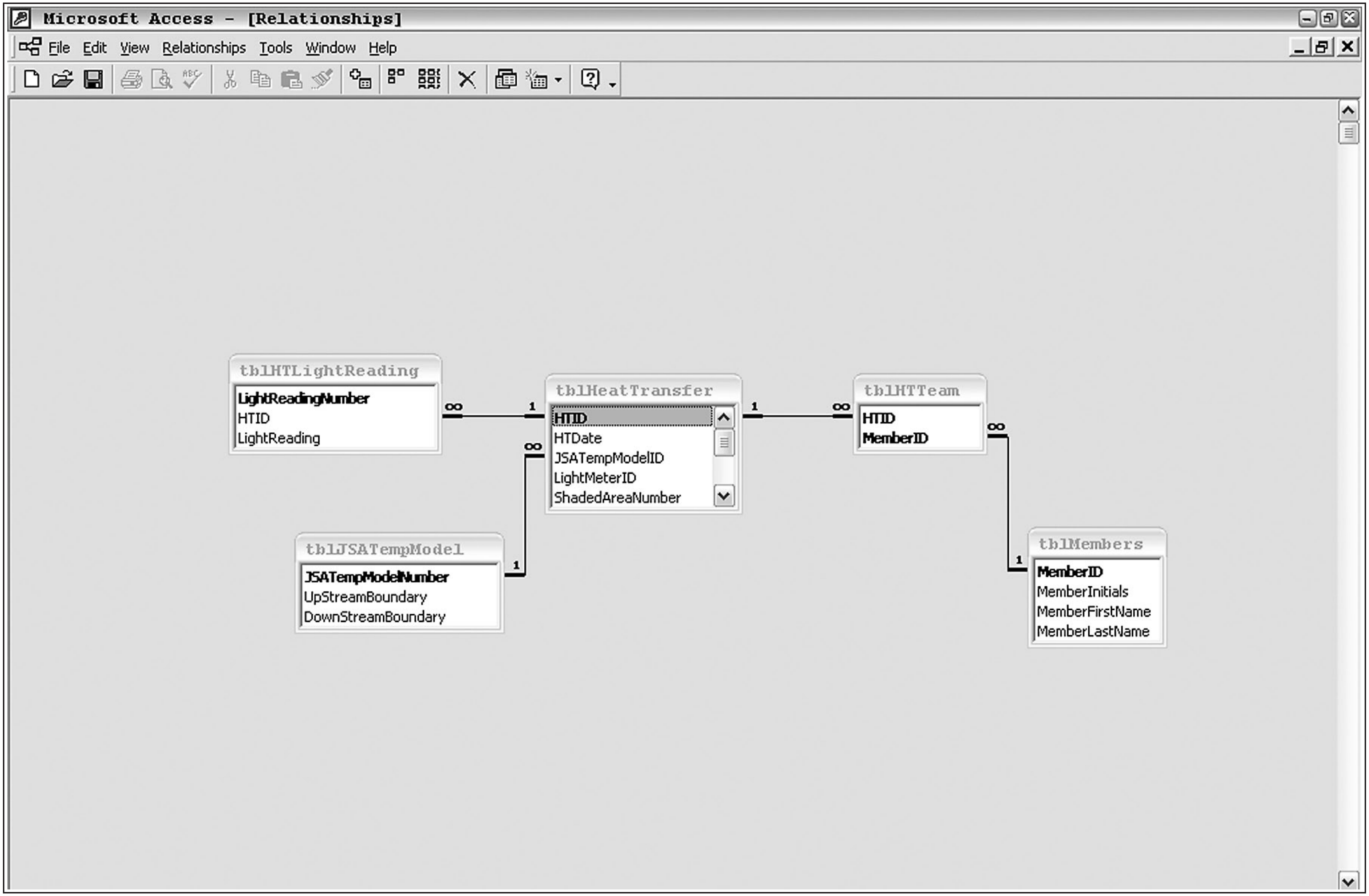

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Figure B-15a
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Solar Heat Transfer (Solar Radiation) Environmental Condition Parameter

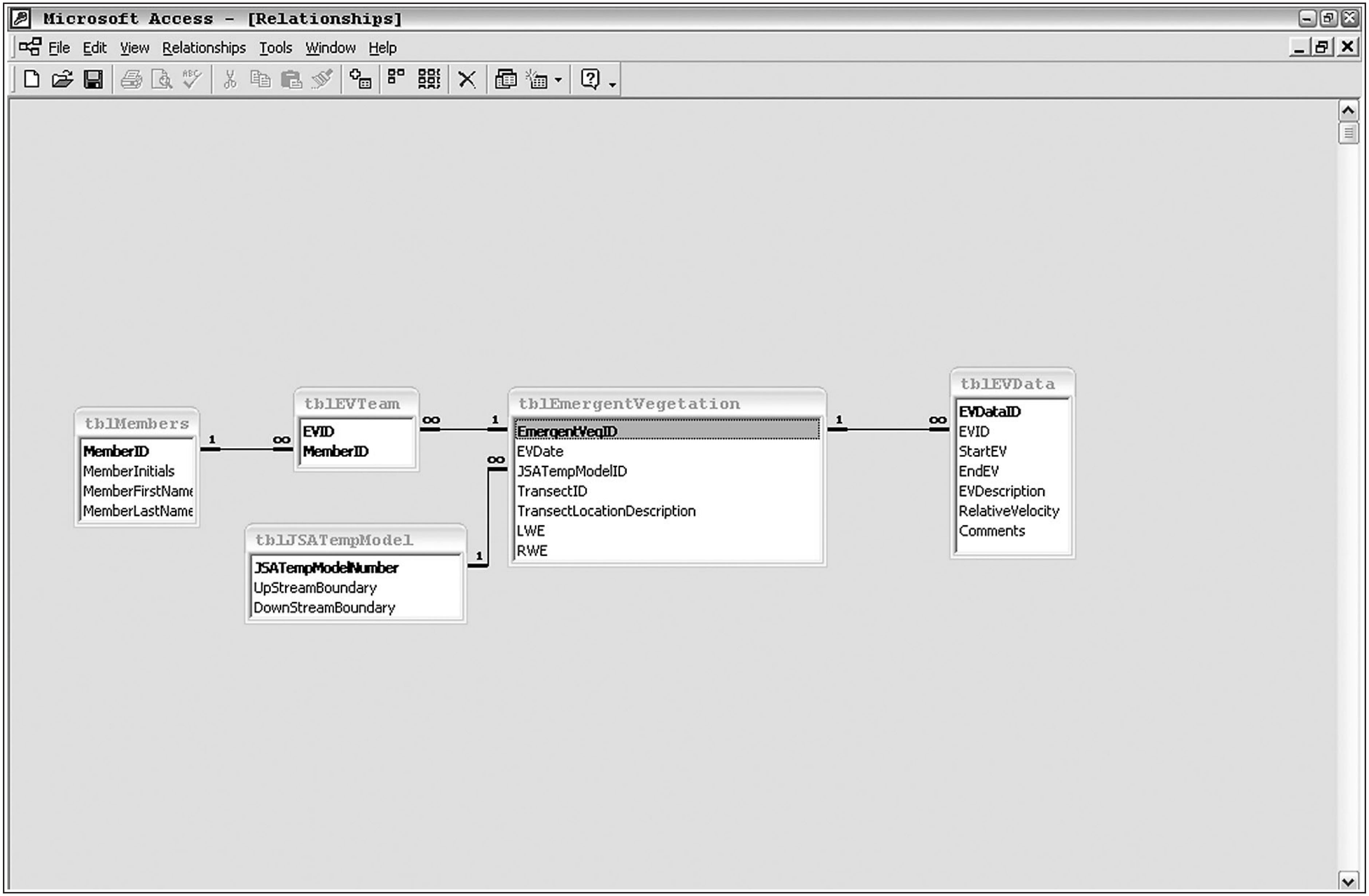

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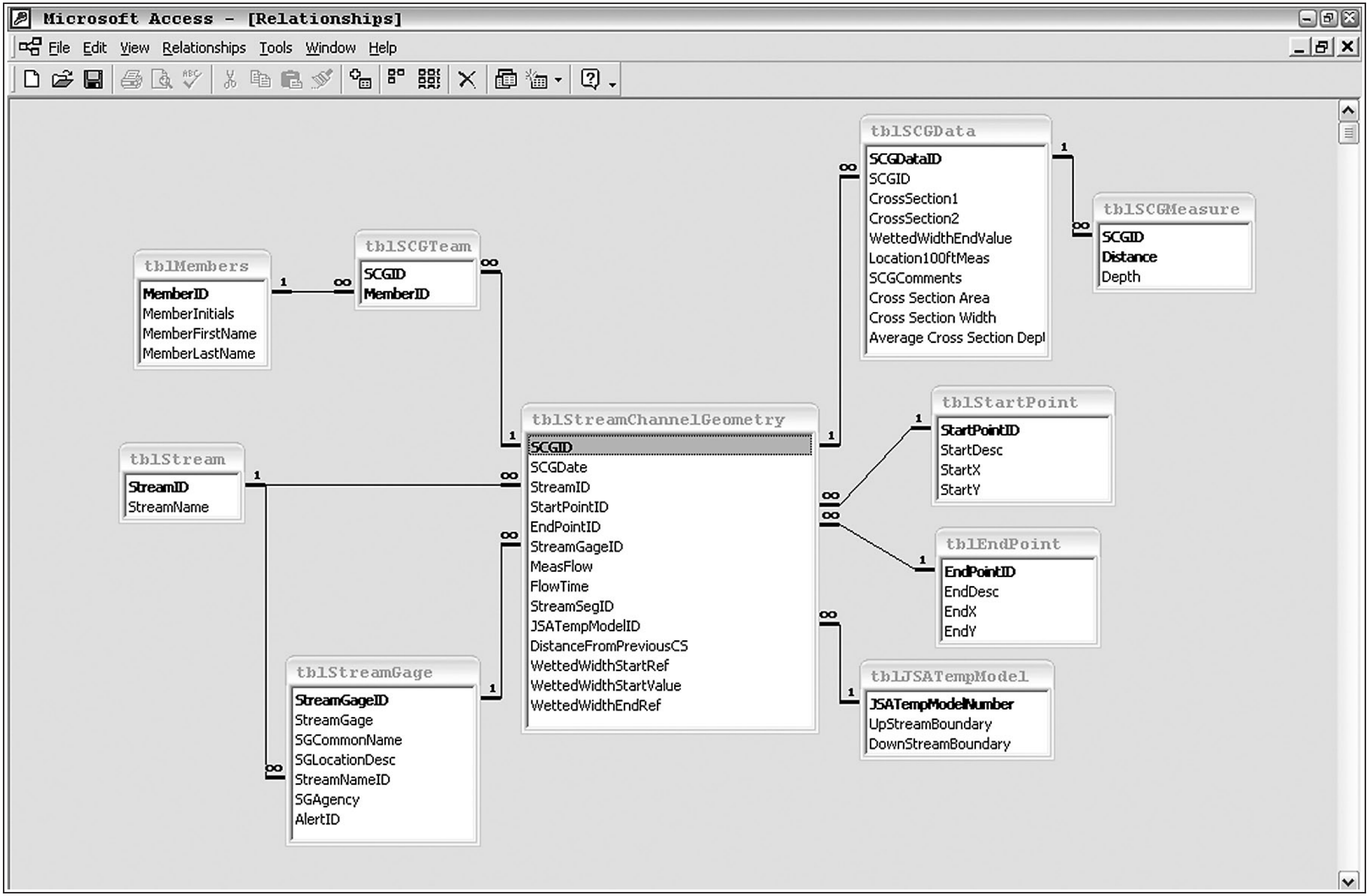
Figure B-15b
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Solar Heat Transfer (Aquatic Vegetation Growth) Environmental Condition Parameter



tblMembers
MemberID
MemberInitials
MemberFirstName
MemberLastName

tblSCGTeam
SCGID
MemberID

tblStream
StreamID
StreamName

tblStreamGage
StreamGageID
StreamGage
SGCommonName
SGLocationDesc
StreamNameID
SGAgency
AlertID

tblStreamChannelGeometry
SCGID
SCGDate
StreamID
StartPointID
EndPointID
StreamGageID
MeasFlow
FlowTime
StreamSegID
JSATempModelID
DistanceFromPreviousCS
WettedWidthStartRef
WettedWidthStartValue
WettedWidthEndRef

tblSCGData
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SCGID
CrossSection1
CrossSection2
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SCGComments
Cross Section Area
Cross Section Width
Average Cross Section Dept

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SCGID
Distance
Depth

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StartPointID
StartDesc
StartX
StartY

tblEndPoint
EndPointID
EndDesc
EndX
EndY

tblJSATempModel
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UpStreamBoundary
DownStreamBoundary

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Figure B-16
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Stream Channel Geometry Environmental Condition Parameter

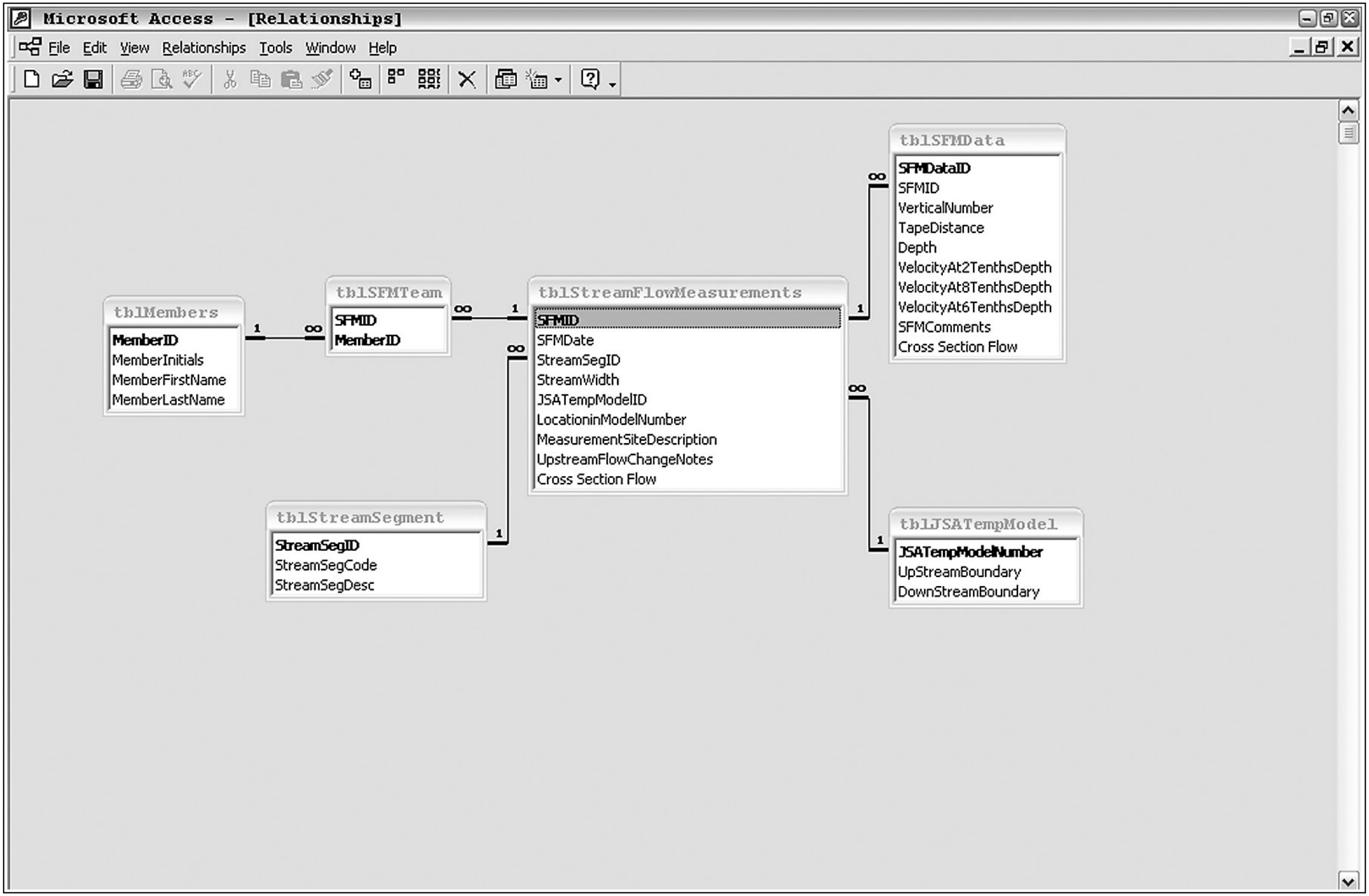

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Figure B-17
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Stream Flow Environmental Condition Parameter

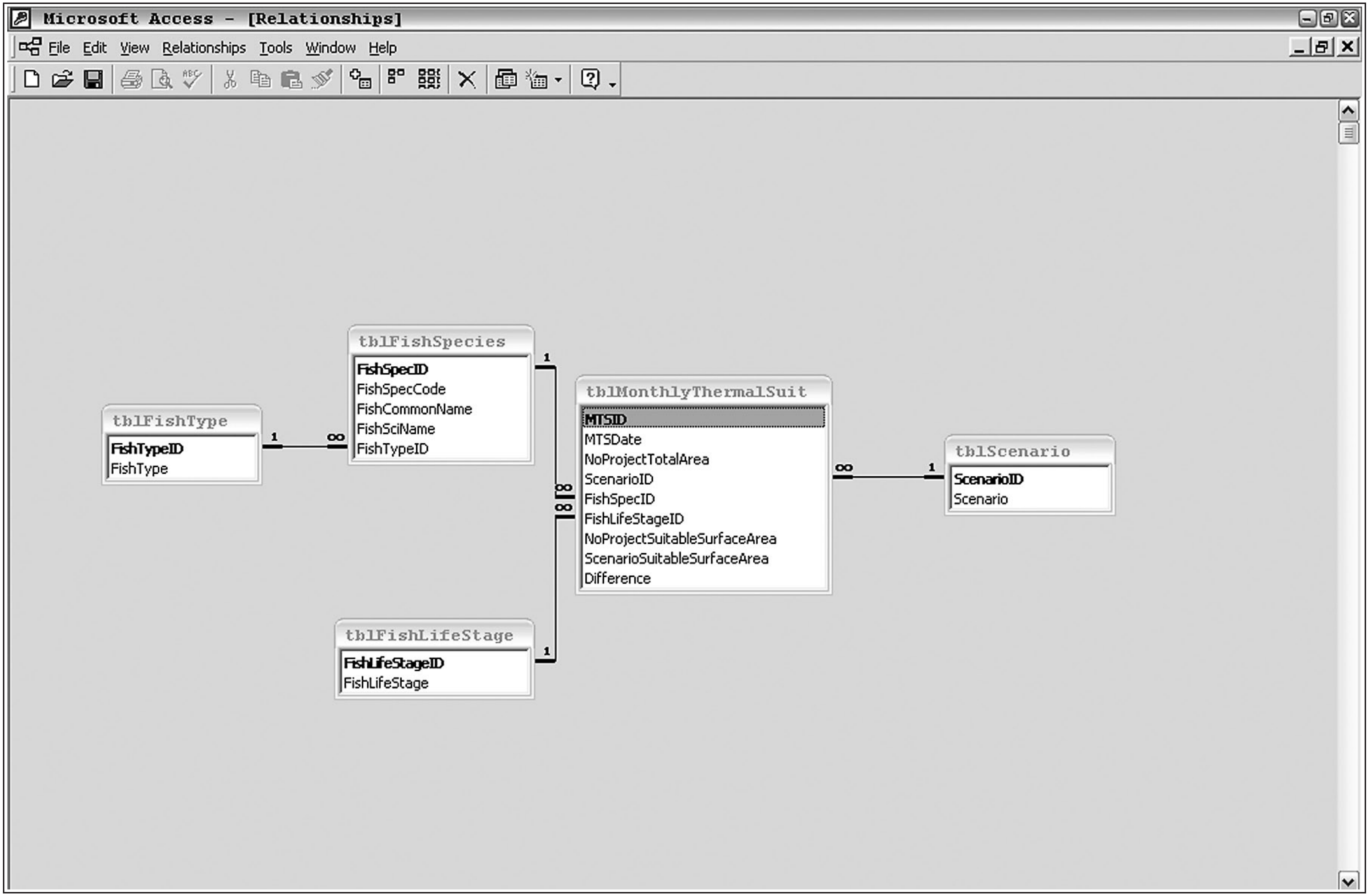

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Figure B-18
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Monthly Thermal Suitability Indicator

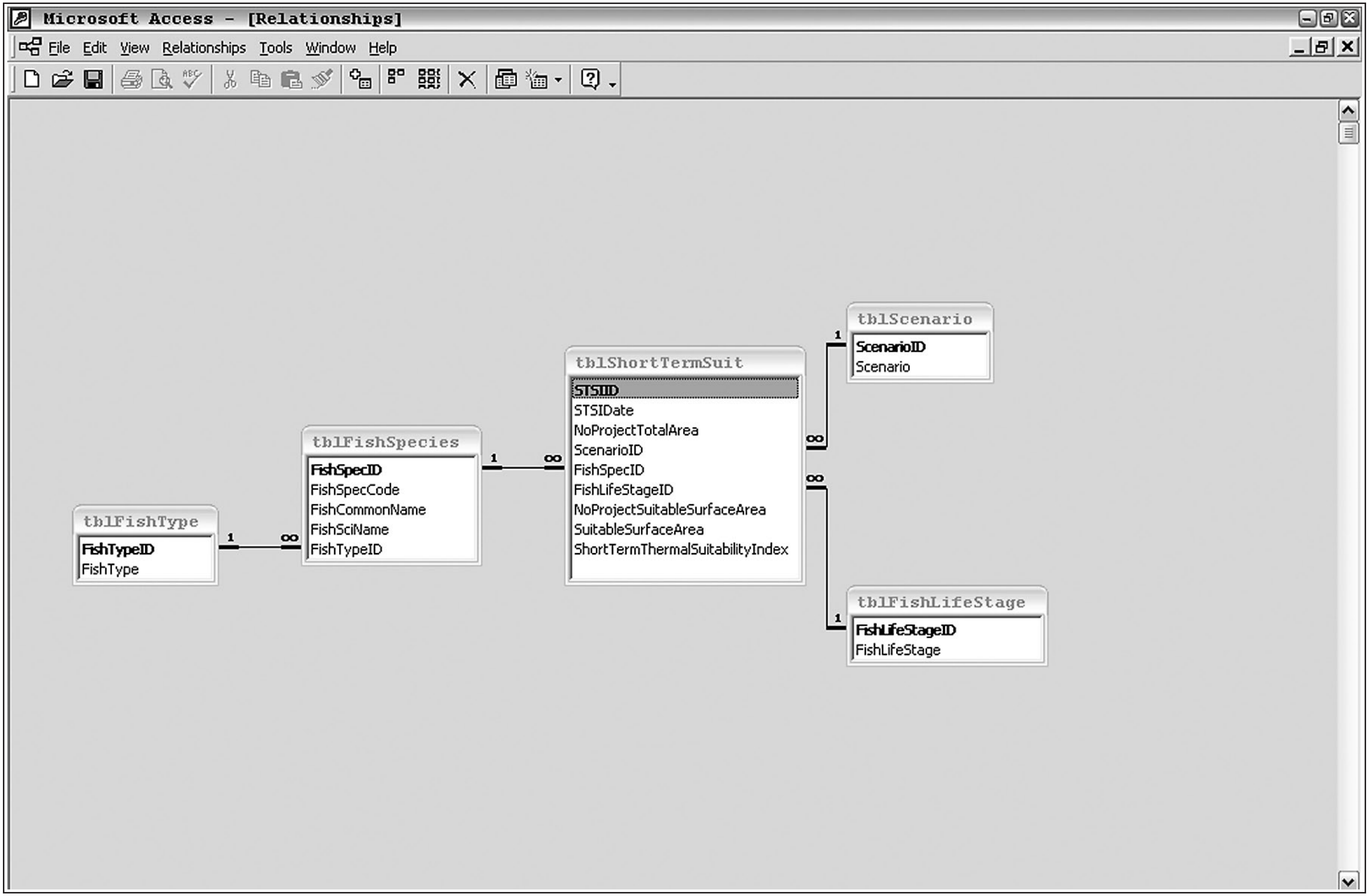

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Figure B-19
Water Temperature — Relationship Diagram of Primary Data and Metadata Tables for the Short-Term Thermal Suitability Indicator

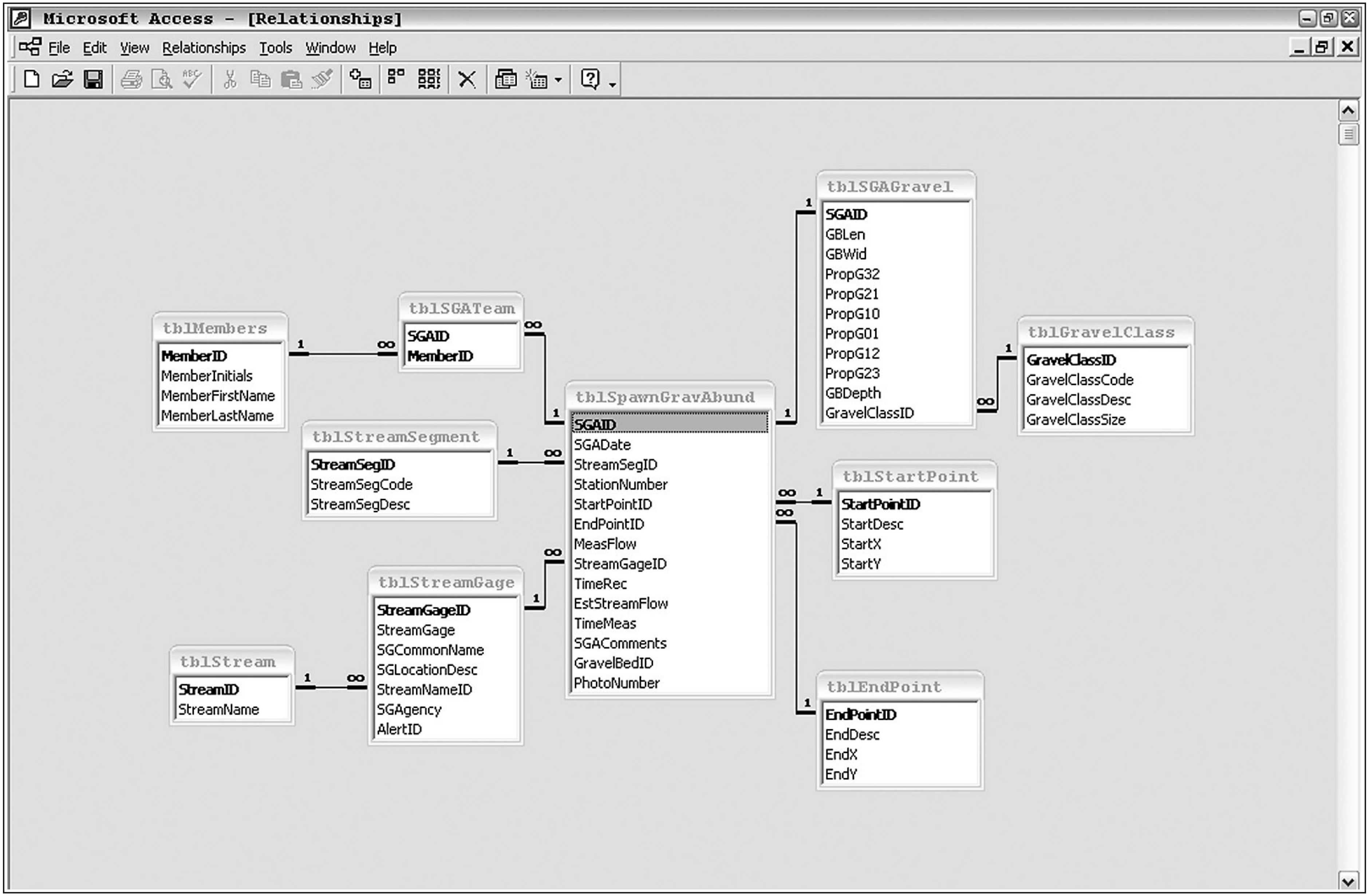

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Figure B-20

Anadromous Fish Spawning Habitat — Relationship Diagram of Primary Data and Metadata Tables for the Spawning Gravel Abundance Indicator

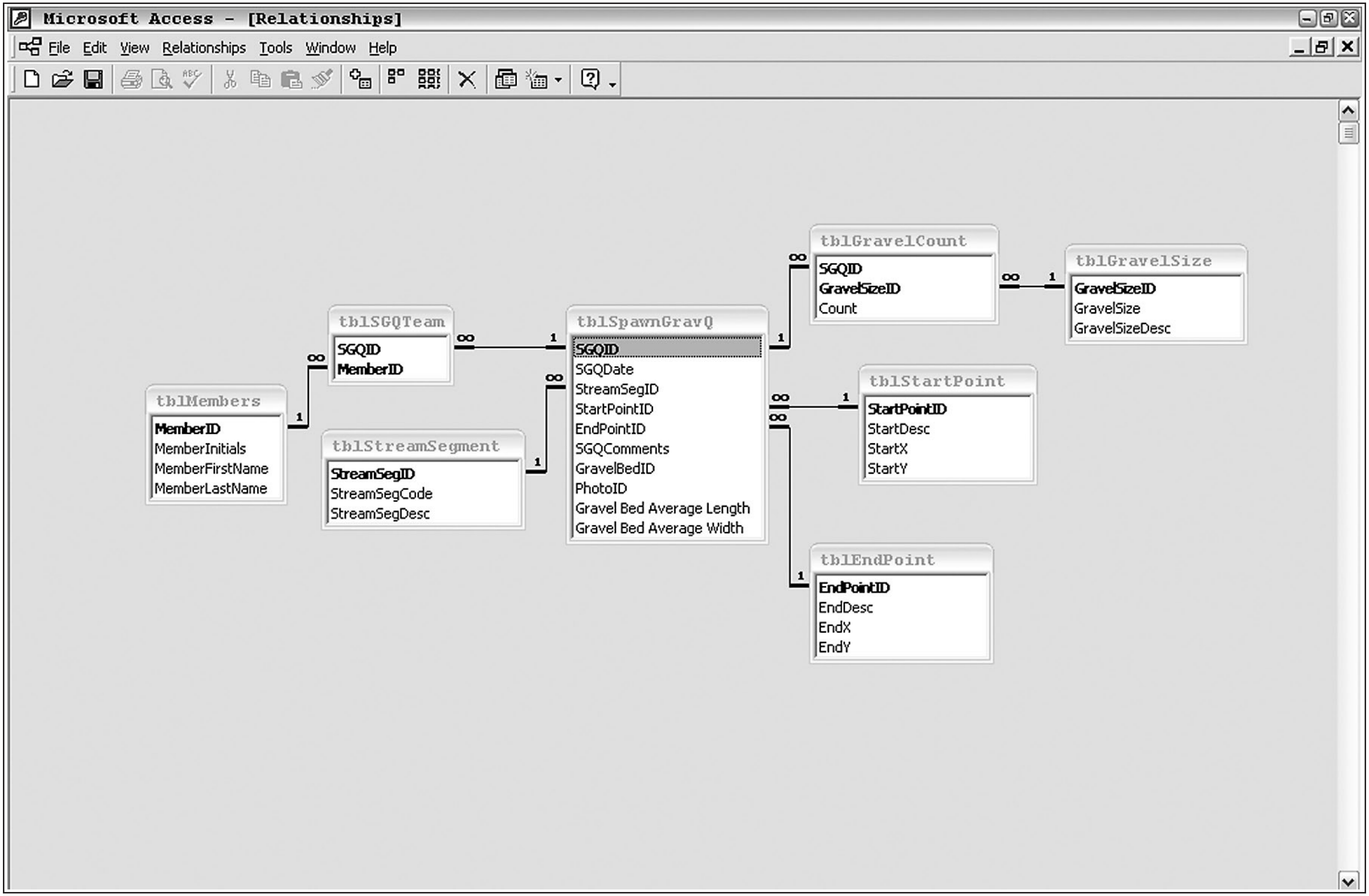

Figure B-21

Anadromous Fish Spawning Habitat — Relationship Diagram of Primary Data and Metadata Tables for the Spawning Gravel Quality Indicator

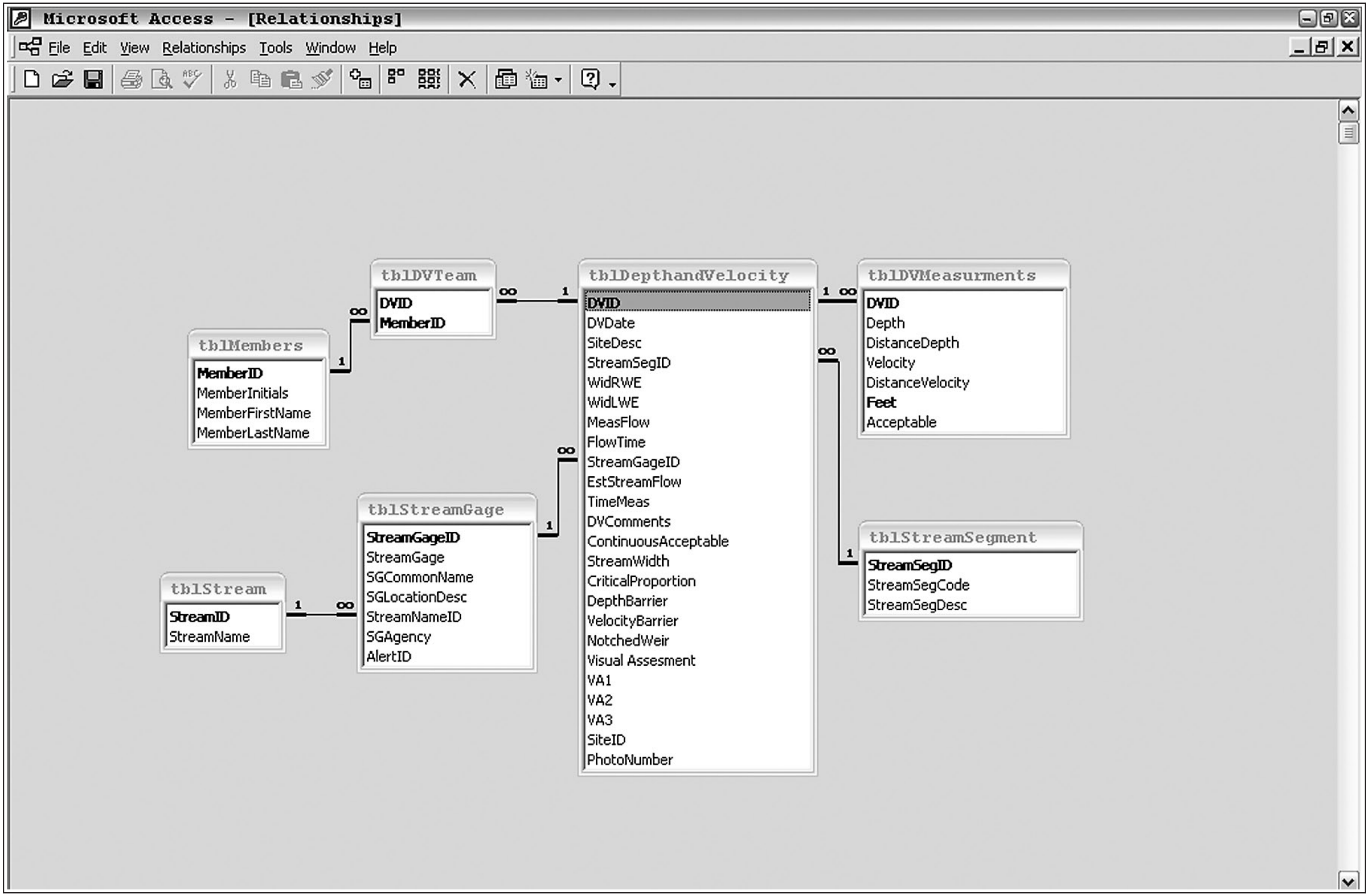

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Figure B-22

Anadromous Fish Passage and Rearing Habitat — Relationship Diagram of Primary Data and Metadata Tables for the Depth and Velocity Indicator

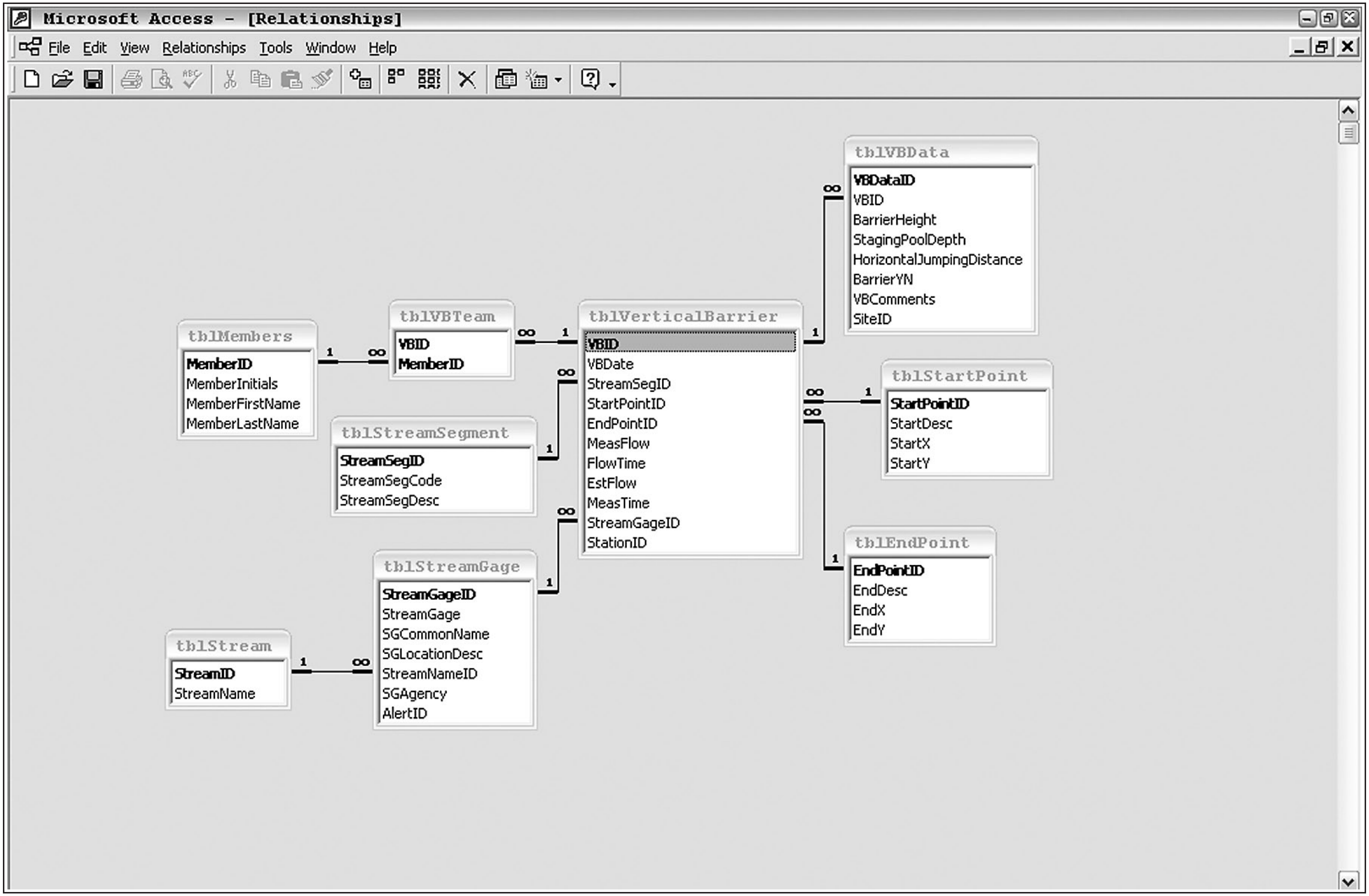

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Figure B-23

Anadromous Fish Passage and Rearing Habitat — Relationship Diagram of Primary Data and Metadata Tables for the Vertical Barrier Indicator

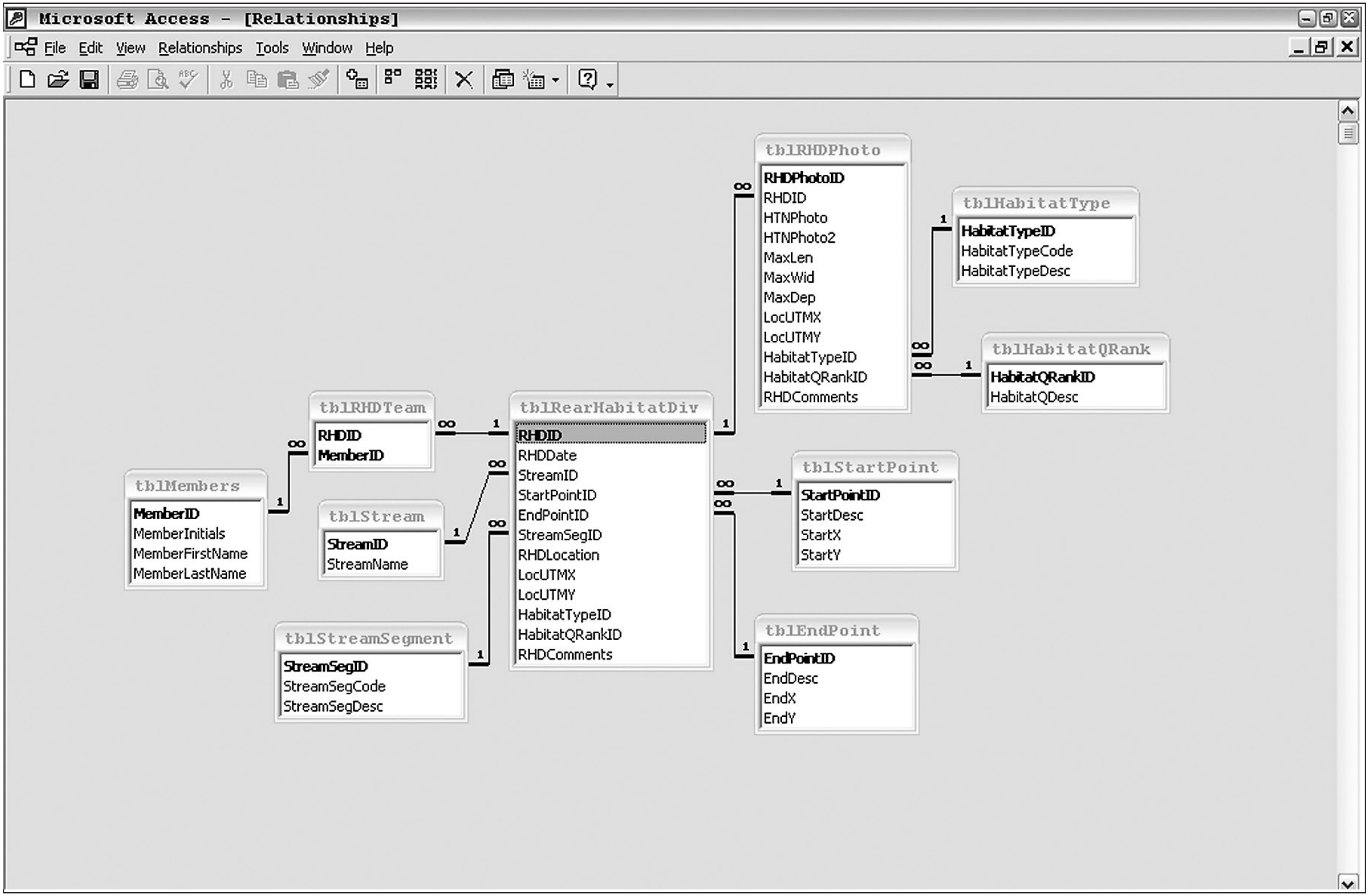

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Figure B-24

Anadromous Fish Passage and Rearing Habitat — Relationship Diagram of Primary Data and Metadata Tables for the Rearing Habitat Diversity Indicator

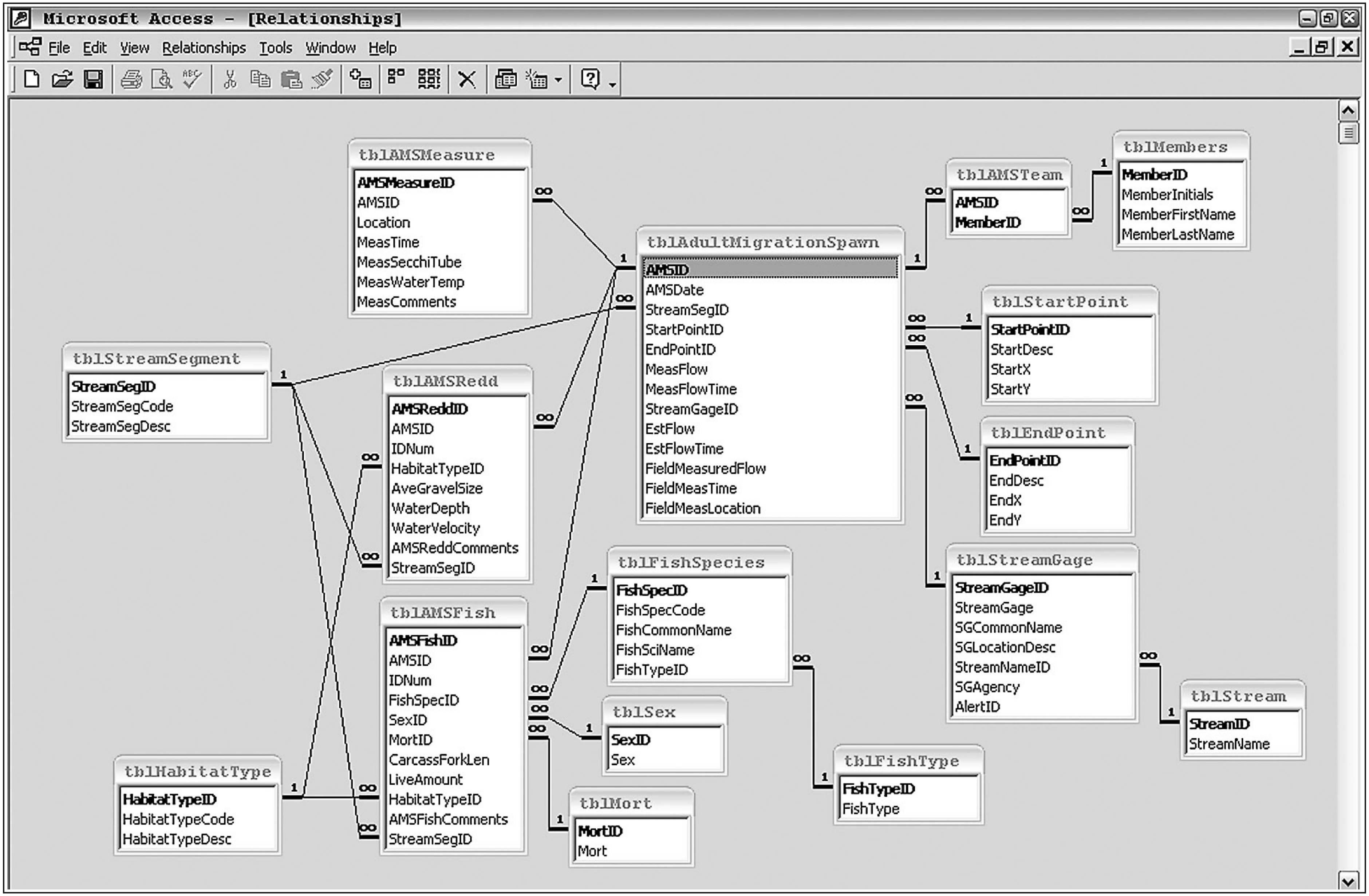

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Figure B-25
Anadromous Fish Occurrence — Relationship Diagram of Primary Data and Metadata Tables for the Adult Migration and Spawning Indicator

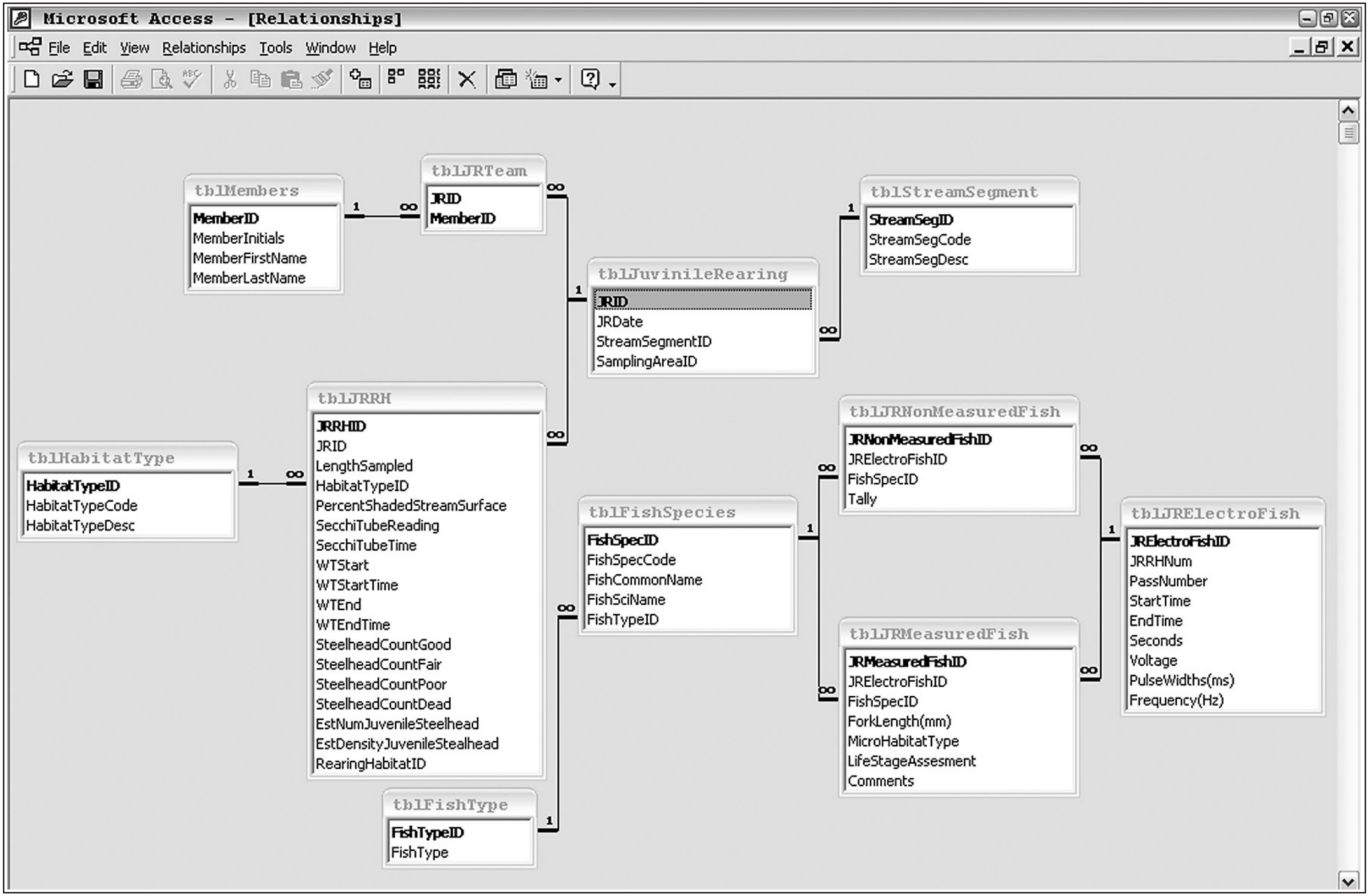

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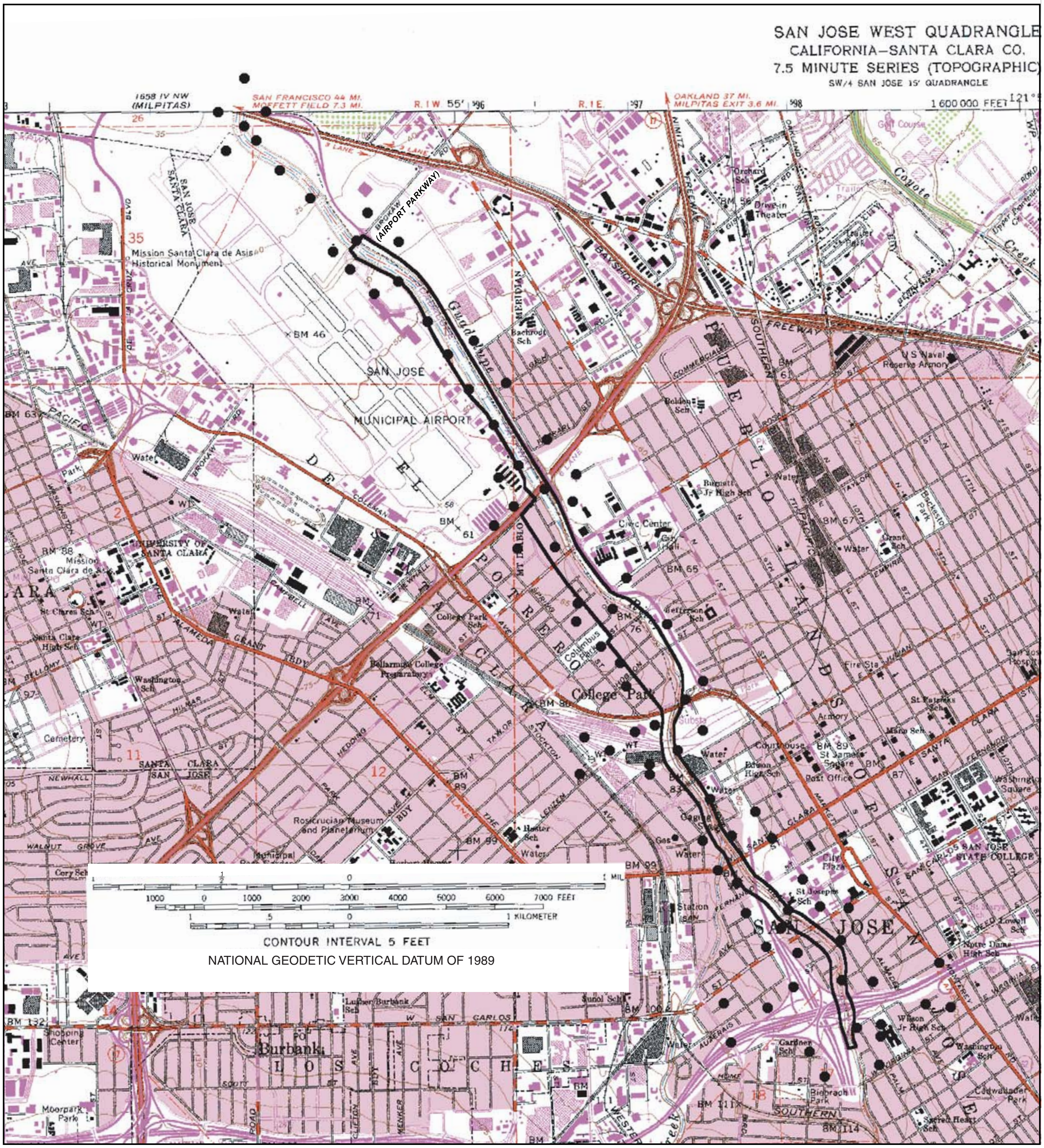
Figure B-26
Anadromous Fish Occurrence — Relationship Diagram of Primary Data and Metadata Tables for the Juvenile Rearing Indicator

Appendix C

Aerial Photograph Control Points


SAN JOSE WEST QUADRANGLE
CALIFORNIA–SANTA CLARA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 SAN JOSE 15' QUADRANGLE
BROKAW (AIRPORT PARKWAY)
SAN JOSE MUNICIPAL AIRPORT
Guadalupe
College Park
SAN JOSE
CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1989

Legend

● Aerial photograph control point

〰 Extent of Segments 1–3 and Reach A

0F028.00-300

Figure C-1
Aerial Photograph Control Points for Segments 1–3 and Reach A

Appendix D

Data Collection Forms

Appendix D
Data Collection Forms

Table D-1. Data Collection Forms for the Implementation Plan for the Guadalupe River Mitigation and Monitoring Plan

Chapter Number and Title	Form Code	Title of Form
4. Riparian Vegetation	RIP-01	Survival and Health and Vigor Data Collection Form
	RIP-02	Qualitative Assessment Data Collection Form
	RIP-03	Natural Recruitment Data Collection Form
	RIP-04	Native and Nonnative Vegetative Cover—Line Intercept Method Data Collection Form (Monitoring Years 4, 5, and 10)
	RIP-05	Nonnative Species Cover—Visual Estimation Method Data Collection Form (Monitoring Years 1–5)
	RIP-06	Tree Height and Basal Area Data Collection Form
	RIP-07	Tree Height and Basal Area Data Collection Form (Bitterlich Method)
5. SRA Cover	SRA-01	Survival and Health and Vigor Data Collection Form
	SRA-02	Qualitative Assessment Data Collection Form
	SRA-03	Natural Recruitment Data Collection Form
	SRA-04	Nonnative Vegetative Cover—Visual Estimate Method Data Collection Form (Monitoring Years 1–5)
	SRA-05	Shaded Stream Surface Data Collection Form
	SRA-06	Bank Stability Data Collection Form
	SRA-07	Instream Cover Data Collection Form
	SRA-08	Channel Bottom Stability Data Collection Form
6. Water Temperature	WATER-01	Measured Water Temperature Data Collection Form
	WATER-02	Solar Radiation Data Collection Form
	WATER-03	Aquatic Vegetation Growth Data Collection Form
	WATER-04	Stream Channel Geometry Data Collection Form

Chapter Number and Title	Form Code	Title of Form
	WATER-05	Stream Flow Measurements Data Collection Form
7. Anadromous Fish Spawning Habitat	FISH-01	Spawning Gravel Abundance Data Collection Form
	FISH-02	Spawning Gravel Quality Data Collection Form
8. Anadromous Fish Passage and Rearing Habitat	FISH-03A	Depth and Velocity Data Collection Form
	FISH-03B	Depth and Velocity Barrier Visual Assessment Data Collection Form
	FISH-04	Vertical Barrier Data Collection Form
	FISH-05	Rearing Habitat Diversity Data Collection Form
	FISH-05A	Rearing Habitat Diversity Riffle/Run Habitat Worksheet
	FISH-05B	Rearing Habitat Diversity Pool Habitat Worksheet
9. Anadromous Fish Occurrence	FISH-06	Adult Migration and Spawning Data Collection Form
	FISH-07-01	Juvenile Rearing Data Collection Form
	FISH-07-02	Juvenile Rearing Data Collection Form
	FISH-08-01	Fry Emergence Data Collection Form
	FISH-08-02	Fry Emergence Data Collection Form
	FISH-08-03	Fry Emergence Data Collection Form
	FISH-08-04	Fry Emergence Data Collection Form

Page ____ of ____

Spawning Gravel Abundance
Data Collection Form FISH-01

Date: ______________________

Monitoring Team Member Names:[a] ______________________

____

Start Point for the Day:[b] ______________________

End Point for the Day:[c] ______________________

Measured Flow[d](cfs):[e] ______________________

Time Recorded: _______ Gage Number: ____________

Visually Estimated Stream Flow (if necessary): _______

____

Time Measured (if necessary): ______________________

Classification of Gravel by Average Size

Gravel Class	Average Size [millimeters (inches)]
Fine gravel	6–25 (0.25–1.0)
Medium gravel	26–50 (1.1–2.0)
Coarse gravel	51–75 (2.1–3.0)
Small cobble	76–102 (3.1–4.0)

Stream Segment[f]	Gravel Bed Identification Number[g]	Gravel Bed (feet)		Percentage of Gravel Area in Each Elevational Unit[h] (feet)						Gravel Bed Depth (nearest 0.1 foot)	Gravel Class Based on Average Size[i]	Comments/Location (Narrative)
		Average Length	Average Width	-3 to -2	-2 to -1	-1 to 0	0 to +1	+1 to +2	+2 to +3			

[a] List first initial and last name of each member of the monitoring team.

[b] Geographic location of start point for data entered on this form.

[c] Geographic location of end point for data entered on this form.

[d] Data obtained from the Santa Clara Valley Water District’s website at http://alert.scvwd.dst.ca.us/gagestrm.html.

[e] cfs=cubic feet per second.

[f] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[g] Number gravel beds sequentially for each water year using the following naming convention: “WY-GRAV-Bed#,” where “WY” is the last 2 digits of the water year (e.g., “01” for 2001) and “Bed#” is a 3-digit bed number (e.g., “001” for first location and “002” for second location). For example, the first gravel bed in water year 2001 would be 01-GRAV-001.

[h] Elevational units are relative to the water surface and describe the depth of the water covering the spawning gravel in 1-foot increments. Negative numbers designate elevational units below the water surface, positive numbers designate elevational units above the water surface, and 0 is the water surface.

[i] Gravel class: see table at top right corner.

Spawning Gravel Quality
Data Collection Form FISH-02

Date: ___________________________

Monitoring Team Member Names:[a] ____

____

Start Point for the Day:[b] ____

End Point for the Day:[c] ____

Numeric Categories of Substrate Particle Size

Category	Average Size [millimeter (inches)]
1	<2 (<0.08)
2	2–5 (0.08–0.2)
3	6–25 (0.3–1.0)
4	26–102 (1.1–4.0)
5	103–152 (4.1–6.0)

Modified from Crouse et al. 1981.

Stream Segment[d]	Gravel Bed Identification Number[e]		Particle Size[f] (millimeters)					Comments/Ground-Level Digital Image Number
			Category 1	Category 2	Category 3	Category 4	Category 5	
		Tally[g]						
		Sum[h]						
		Tally[g]						
		Sum[h]						
		Tally[g]						
		Sum[h]						
		Tally[g]						
		Sum[h]						

[a] List first initial and last name of each member of the monitoring team.

[b] Geographic location of start point for data entered on this form.

[c] Geographic location of end point for data entered on this form.

[d] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; Guadalupe Creek; Upper Guadalupe River (upstream of Grant Street); or Los Gatos Creek.

[e] Use gravel bed identification number from the Spawning Gravel Abundance Data Collection Form FISH-01.

[f] Particle size: see table at top right corner.

[g] Keep a tally for each category and then sum the totals.

[h] Total of particles within category.

Page ___ of ___

Depth and Velocity
Data Collection Form FISH-03A

Date: ______________________

Monitoring Team Member Names:[a] __________

____

Stream Segment:[b] ______________________

____

Potential Barrier Identification Number:[c]

____

Site Description: ____

____

Wetted Channel Width (feet): LWE[d]____-RWE[d]_____= _________________

Measured Flow[e] (cfs):[f] ____

Time Recorded:__________ Gage Number:_____________________

Visually Estimated or Field-Measured Stream Flow (if necessary):___________

Time Measured (if necessary): _________________________________

Summary of Professional Judgment
(Check all that apply)

☐ Potential barrier passable to fish at current flow conditions.

☐ Potential barrier is an actual depth barrier.

☐ Potential barrier is an actual velocity barrier.

		Depth (feet) and Velocity (fps)[g] Measurements at 2-Foot Intervals along Cross Section[h]																			
		2[i]	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
Potential Depth Barrier	Depth (to nearest 0.1 foot)																				
	Stream length of depth <1.0 foot[i] (to nearest 0.1 foot)																				
Potential Velocity Barrier	Velocity (to nearest 0.1 foot per second)																				
	Stream length of velocity >5.0 feet per second[j] (to nearest 0.1 foot)																				
Assessment	Depth *and* velocity criteria met? (Y/N)[k]																				

Comments:

Ground-Level Digital Image Numbers:

Field Calculations Worksheet

A = passage corridor width = largest number of continuous intervals where depth and/or velocity criteria are met _________ x 2 = _________

B = reference number = 4 **or** wetted channel width __________x 0.10 = __________ (whichever is greater) [l]

Is A < B? ☐ No (no barrier, go to next line) ☐ Yes (indicate type of barrier: ☐ depth ☐ velocity ☐ both)

Is potential barrier a notched weir? ☐ Yes (conduct a vertical barrier assessment) ☐ No

Professional Judgement:

Depth and Velocity
Data Collection Form FISH-03A

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Number potential fish passage barriers sequentially for each water year using the following naming convention: "WY–BARR–Barrier #," where "WY" is the last 2 digits of the water year (e.g., "01" for 2001) and "Barrier #" is a 3-digit barrier number (e.g., "001" for first potential fish barrier and "002" for second). For example, the first potential fish barrier in water year 2001 would be 01-BARR-001.

[d] LWE = left water's edge; RWE = right water's edge. Left and right banks are relative to a person facing downstream.

[e] Data obtained from the Santa Clara Valley Water District's web site at http://alert.scvwd.dst.ca.us/gagestrm.html.

[f] Cubic feet per second.

[g] Feet per second.

[h] If the cross section is less than 5 feet wide, take only 1 measurement at the center of the cross section.

[i] Stream length, perpendicular to the cross section and within the specified cross-section interval, upstream and downstream from the cross section of depth less than 1 foot.

[j] Stream length, perpendicular to the cross section and within the specified cross-section interval, upstream and downstream from the cross section of velocity greater than 5 feet per second.

[k] Y = interval **meets** both minimum depth and maximum velocity criteria (i.e., depth greater than 1 foot or depth less than 1 foot extends for less than 6 feet of channel length and velocity less than or equal to 5 fps or velocity greater than 5 fps extends for less than 6 feet of channel length).

N = interval **does not meet** both minimum depth and maximum velocity criteria (i.e., depth less than or equal to 1 foot extends for more than 6 feet of channel length and/or velocity greater than 5 fps extends for more than 6 feet of channel length).

[l] If stream width times 0.10 is greater than 4, use this number as reference number. Otherwise, use 4 as reference number.

Diagram of Site

Depth and Velocity Barrier Visual Assessment
Data Collection Form FISH-03B

Date: ______________________

Gage-Measured Flow[b] (cfs):[c] ________________________________

Monitoring Team Member Names:[a] ____________________________________

Time Recorded: ____________________ Gage Number: __________________

Stream Segment[d]	Potential Barrier Identification Number[e]	Site Description	Field Measured Flow (cfs)	Time Measured	Barrier[f]			Comments/Ground-Level Digital Image Numbers
					Depth	Velocity	Not a Barrier	

[a] List first initial and last name of each member of the monitoring team.

[b] Data obtained from the Santa Clara Valley Water District's web site at http://alert.scvwd.dst.ca.us/gagestrm.html.

[c] cfs=cubic feet per second.

[d] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[e] Number potential fish passage barriers sequentially for each water year using the following naming convention: "WY–BARR–Barrier #," where "WY" is the last 2 digits of the water year (e.g., "01" for 2001) and "Barrier #" is a 3-digit barrier number (e.g., "001" for first potential fish barrier and "002" for second). For example, the first potential fish barrier in water year 2001 would be 01-BARR-001.

[f] Based on professional judgment, indicate if the potential barrier is an actual depth or velocity barrier or not an actual barrier.

Page ___ of ___

Vertical Barrier
Data Collection Form FISH-04

Date: ______________________

Gage-Measured Flow[d] (cfs):[e] ____

Monitoring Team Member Names:[a] ____________________________________

Time Recorded: ____________________Gage Number: __________________

Start Point for the Day:[b] ____

Visually Estimated or Field-Measured Flow (if necessary): __________________

End Point for the Day:[c] ____

Time Measured (if necessary): ____

Stream Segment[f]	Potential Barrier Identification Number[g]	Barrier Height (feet)[h]	Staging Pool Depth (feet)[i]	Horizontal Distance[j]	Barrier[k] (Y/N)	Comments/Ground-Level Digital Image Numbers/Location (narrative)

[a] List first initial and last name of each member of the monitoring team.

[b] Geographic location of start point for data entered on this form.

[c] Geographic location of end point for data entered on this form.

[d] Data obtained from the Santa Clara Valley Water District’s web site at http://alert.scvwd.dst.ca.us/gagestrm.html.

[e] cfs=cubic feet per second.

[f] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[g] Number potential fish passage barriers sequentially for each water year using the following naming convention: “WY–BARR–Barrier #,” where “WY” is the last 2 digits of the water year (e.g., “01” for 2001) and “Barrier #” is a 3-digit barrier number (e.g., “001” for first potential fish barrier and “002” for second). For example, the first potential fish barrier in water year 2001 would be 01-BARR-001.

[h] Measure vertical distance (to the nearest 0.1 foot) from the water surface to the lowest point of the potential barrier.

[i] Measure depth (to the nearest 0.1 foot) at location where fish are expected to initiate leaps from staging pool.

[j] Distance from staging pool below potential barrier to location where depth upstream of the barrier first reaches 1 foot (measured to the nearest 0.1 foot).

[k] The potential barrier is a barrier to fish passage if barrier is more than 3.0 feet high, horizontal distance is greater than 5.4 feet, OR staging pool depth is less than 1.25 times the height of the potential barrier.

Rearing Habitat Diversity
Data Collection Form FISH-05

Date: ______________________

Start Point for the Day:[b] ____

Monitoring Team Member Names:[a] ____________________________________

End Point for the Day:[c] ____

Stream Segment[d]	Habitat Identification Number[e]	Maximum Length[f] (feet)	Maximum Width (feet)	Maximum Depth (feet)	Habitat Quality Ranking (from worksheet)	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] Geographic location of start point for data entered on this form.

[c] Geographic location of end point for data entered on this form.

[d] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek. If a habitat type spans stream segments, the entire habitat type should be assigned to the most downstream segment.

[e] From worksheet.

[f] Determine length of habitat unit from mapping information on aerial photographs.

Page ___ of ___

Rearing Habitat Diversity
Riffle/Run Habitat Worksheet FISH-05A

Date: ______________________

Monitoring Team Member Names:[a] ____________________

____

____

Score		Habitat Component				
					Bank Composition[b, c]	
Numeric	Narrative	Embeddedness[b] (% fines)	Instream Cover[b] (logs, debris piles, boulders, overhanging banks, and vegetation) (%)	Canopy Coverage[b] (%) (stream area shaded between 1000 and 1400 hours)	Rooted Vegetation and Stable Rocky Ground Cover along Bank (%)	Bank Slope (%) and Condition
1	Good	≤ 10	≥ 10	≥ 50	≥ 75	< 30; not actively eroding
2	Fair	11–45	4–9	10–49	26–74	30–60
3	Poor	> 45	< 4	< 10	≤ 25	> 60; actively eroding

Habitat Identification Number[d]	Habitat Component (scores between 1 and 3)				Total Score
	Embeddedness	Instream Cover	Canopy Coverage	Bank Composition	

Comments:

---

[a] List first initial and last name of each member of the monitoring team.

[b] Source: U.S. Fish and Wildlife Service, 1984. *Habitat Suitability Information: Rainbow Trout*. FWS/OBS-82/10.60.

Embeddedness = V_{16}; Cover = V_8; Canopy = V_{17}; Bank Composition = V_{12}.

[c] Source: Pfankuch, 1975. *Channel Stability Evaluation.*

[d] Use the following abbreviations: pool = POOL; riffle = RIFF; and run = RUNN. Use the following sequential naming convention for habitat units during habitat typing: last 2 digits of water year, abbreviation for habitat unit, and 3-digit sequential number pertaining to the order of the habitat unit. For example, the first habitat unit mapped in water year 2001 would be 01-RIFF-001 if the first habitat unit was a riffle.

Page ___ of ___

Rearing Habitat Diversity
Pool Habitat Worksheet FISH-05B

Date: ______________________

Monitoring Team Member Names:[a] ____________________

____

____

Score		Habitat Component					
			Cover[b]			Bank Composition[b, c]	
Numeric	Narrative	Residual Pool Depth (feet)[b]	Instream Cover (logs, debris piles, boulders, overhanging banks, and vegetation) (%)	Number of Types	Canopy Coverage[b] (%) (stream area shaded between 1000 and 1400 hours)	Rooted Vegetation and Stable Rocky Ground Cover along Bank (%)	Bank Slope (%) and Condition
1	Good	> 4.9	> 30	$3	> 50	≥ 75	< 30; not actively eroding
2	Fair	1– 4.8	5– 30	1–3	10–49	26–74	30–60%
3	Poor	<1	< 5	0–1	< 10	≤ 25	> 60; actively eroding

	Pool Depth Measurements (feet)			Habitat Component (scores from 1 to 3)				
Habitat Identification Number	Maximum Pool Depth	Riffle Crest Depth[e]	Residual Pool Depth[f]	Residual Pool Depth	Instream Cover	Canopy Coverage	Bank Composition	Total Score
Comments:								

---

[a] List first initial and last name of each member of the monitoring team.

[b] Source: U.S. Fish and Wildlife Service. 1984. Habitat Suitability Information: Rainbow Trout. FWS/OBS-82/10.60. Residual Pool Depth = V_{15}; Cover = V_{15}; Canopy = V_{17}; Bank Composition = V_{12}.

[c] Source: Pfankuch, 1975. *Channel Stability Evaluation*.

[d] Use the following abbreviations: pool = POOL; riffle = RIFF; and run = RUNN. Use the following sequential naming convention for habitat units during habitat typing: last 2 digits of water year, abbreviation for habitat unit, and 3-digit sequential number pertaining to the order of the habitat unit. For example, the first habitat unit mapped in water year 2001 would be 01-RIFF-001 if the first habitat unit was a riffle.

[e] The deepest point in the shallowest continuous line perpendicular to the riffle.

[f] *Maximum Pool Depth* minus *Riffle Crest Depth*.

Adult Migration and Spawning
Data Collection Form FISH-06

Date: ______________________________

Monitoring Team Member Names:[a]

____

____

Start Point for the Day:[b] _______________

End Point for the Day:[c] _______________

Gage-Measured Flow[d] (cfs):[e] __________

Time Recorded: ____________________

Gage Number: ______________________

Field-Measured Stream Flow:[f] ______________________

Secchi Tube Readings and Water Temperature Measurements

Location (Narrative)	Secchi Tube Reading (millimeters)	Time	Water Temperature (°F)	Comments

Live Fish/Carcasses

Stream Segment[f, g]	Live Fish/Carcass Identification Number[h]	5-Letter Species Code[i]	Live or Carcass	Fork Length (centimeters) (carcass only)	Sex (M,F,U)[j]	Habitat Type (pool, riffle, run)	Comments/Location (narrative or GPS identification number)

Adult Migration and Spawning
Data Collection Form FISH-06

Redds

Stream Segment[g]	Redd Identification Number[k]	Habitat Type (pool, riffle, run)	Average Gravel Size (inches[l])	Water Depth (feet)	Water Velocity (feet/second)	Comments/Location (narrative or GPS identification number)

[a] List first initial and last name of each member of the monitoring team.

[b] Geographic location of start point for data entered on this form.

[c] Geographic location of end point for data entered on this form.

[d] Data obtained from the Santa Clara Valley Water District's web site at www.scvwd.dst.ca.us/gagestrm.html.

[e] cfs = cubic feet per second.

[f] Collected during the depth and velocity barrier monitoring.

[g] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[h] Number live fish and carcasses sequentially for each water year using the following naming convention: "WY–FISH–Fish #," where "WY" is the last 2 digits of the water year (e.g., "01" for 2001) and "Fish #" is a 3-digit fish/carcass number (e.g., "001" for first fish/carcass and "002" for second fish/carcass). For example, the first live fish or carcass observed in water year 2001 would be 01-FISH-001.

[i] Indicate steelhead = ONMYK or Chinook salmon = ONTSA.

[j] M = Male; F = Female; U = Unknown.

[k] Number redds sequentially for each water year using the similar naming convention as that used for live fish and carcasses, except replace "FISH" with 'REDD." For example, the first redd observed in water year 2001 would be 01-REDD-001.

[l] Suitable gravel sizes range from 6 to 102 millimeters (0.25 to 4 inches).

Juvenile Rearing
Data Collection Form FISH-07-01

Date: ______________________________

Monitoring Team Member Names:[a] ______________________________

____

Stream Segment:[b] ______________________________

Sampling Area Identification Number:[c] ______________________________

Rearing Habitat Identification Number:[d] ______________________________

Length of Rearing Habitat Sampled: ______________________________

Rearing Habitat Type Sampled (pool, riffle, run):[e] ________________

Percentage of Stream Surface Shaded:[f] ________________

Secchi Tube Reading (millimeters):__________at: __________ (time)

Water Temperature (°F) at start of sampling _______ at:______ (time)

Water Temperature (°F) when fish are released ____ at:______ (time)

Number of Steelhead Released in Following Condition:[g]

Good________ Fair_________ Poor ________ Dead _______

Habitat Data

Sampling Area 10-Foot Segment[h]	Instream Cover[i] (%)	Dominant Substrate (clay, sand, gravel, cobble, riprap)	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, 3A, 3B or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Number juvenile rearing sampling reaches sequentially for each water year using the following naming convention: "WY-JUVE-Reach #," where "WY" is the last 2 digits of the water year (e.g., "01" for 2001) and "Reach #" is a 3-digit reach number (e.g., "001" for first juvenile rearing sampling reach and "002" for second). For example, the first juvenile rearing sampling reach in water year 2001 would be 01-JUVE-001.

[d] The most recent rearing habitat diversity identification number for the habitat type being sampled (from the FISH-05 data collection form).

[e] The most recent rearing habitat diversity designation (from the FISH-05 data collection form).

[f] Record the visually estimated percentage of shaded stream surface for the habitat type.

[g] For steelhead, indicate health upon release as follows: good=fish immediately swam to cover; fair=fish oriented with the current and moved slowly to cover; poor=fish had difficulty orienting with the current and swimming to cover; or dead=fish died.

[h] Record the downstream tape measurement of each 10-foot segment of the sampling area, beginning at the downstream end (e.g., 0, 10, 20). Record the percentage of instream cover, habitat type, and dominant substrate for each segment.

[i] From instream cover data collection form (SRA-07).

Juvenile Rearing
Data Collection Form FISH-07-01

5-Letter Species Code	Common Name	Scientific Name
AMMEL	Black bullhead	*Ameiurus melas*
AMNEB	Brown bullhead	*Ameiurus nebulosus*
ARAUR	Goldfish	*arassius auratus*
CAOCC	Sacramento sucker	*Catostomus occidentalis*
COASP	Prickly sculpin	*Cottus asper*
COGUL	Riffle sculpin	*Cottus gulosus*
CYCAR	Carp	*Cyprinus carpio*
DOPET	Threadfin shad	*Dorosoma petenense*
GAACU	Three-spined stickleback	*Gasterosteus aculeatus*
GAAFF	Western mosquitofish	*Gambusia affinis*
ICPUN	Channel catfish	*Ictalurus punctatus*
LAEXI	Hitch	*Lavinia exilicauda*
LASYM	California roach	*Lavinia symmetricus*
LATRI	Pacific lamprey	*Lampetera tridentata*
LECYA	Green sunfish	*Lepomis cyanellus*
LEGIB	Pumpkinseed	*Lepomis gibbosus*
LEMAC	Bluegill	*Lepomis macrochirus*
LEMIC	Redear sunfish	*Lepomis microlophus*
LUPAR	Rainwater killfish	*Lucania parva*
MEBER	Inland silverside	*Menidia beryllina*
MIDOL	Smallmouth bass	*Micropterus dolomieu*
MISAL	Largemouth bass	*Micropterus salmoides*
NOCRY	Golden shiner	*Notemigonus crysoleucas*
ONMYK	Steelhead	*Oncorhynchus mykiss*
ONTSA	Chinook salmon	*Oncorhynchus tshawytscha*
POANN	White crappie	*Pomoxis annularis*
PONIG	Black crappie	*Pomoxis nigromaculatus*

Juvenile Rearing
Data Collection Form FISH-07-02

Date: ______________________________

Sampling Area Identification Number:[a] __________

Rearing Habitat Identification Number:[b] __________

Electrofishing Pass Number:[c] ______________

Start Time for Electrofishing Pass: ___________

End Time for Electrofishing Pass: ____________

Electrofishing Seconds: ___________

Electrofishing Settings:

Voltage: _______ Pulse Width _________ (milliseconds)

Frequency: ________ (Hertz)

Fish Data

Measured Fish[d]

5-Letter Species Code[e]	Fork Length (mm)[f]	Salmonids Only		5-Letter Species Code[e]	Fork Length (mm)[f]	Salmonids Only	
		Microhabitat Type (pocket water, woody material, undercut banks, fast water, backwater pool)	Life Stage Assessment[g]			Microhabitat Type (pocket water, woody material, undercut banks, fast water, backwater pool)	Life Stage Assessment[g]
Comments:							

[a] From data collection form FISH-07-01. The unique identification number for each juvenile rearing sampling reach (e.g., 01-JUVE-001).

[b] From data collection form FISH-07-01. The most recent rearing habitat diversity identification number for the habitat type being sampled.

[c] Each habitat type is sampled 2–3 times; record the sampling pass number for which data are being collected.

[d] Measure all salmonids and a random sample (at least 30 individuals) of all other species.

[e] A lookup table with the 5-letter species codes is on the back of data collection form FISH-07-01.

[f] Measure the fork length of all salmonids and a random sample (at least 30 individuals) of all other species.

[g] Life stage assessment codes are as follows: 1=yolk sac fry; 2=fry; 3=parr; 4=silvery parr; and 5=smolt. See table 9-1 for description of life stages.

Juvenile Rearing
Data Collection Form FISH-07-02

Fish Data (continued)

Measured Fish[d]

5-letter Species Code[e]	Fork Length (mm)[f]	Salmonids Only		5-letter Species Code[e]	Fork Length (mm)[f]	Salmonids Only	
		Microhabitat Type (pocket water, woody material, undercut banks, fast water, backwater pool)	Life Stage Assessment[g]			Microhabitat Type (pocket water, woody material, undercut banks, fast water, backwater pool)	Life Stage Assessment[g]
Comments:							

Nonsalmonids Not Measured (Tallied)[h]

5-Letter Species Code	Tally	5-Letter Species Code	Tally

[d] Measure all salmonids and a random sample (at least 30 individuals) of all other species.

[e] A lookup table with the 5-letter species codes is on the back of data collection form FISH-07-01.

[f] Measure the fork length of all salmonids and a random sample (at least 30 individuals) of all other species.

[g] Life stage assessment codes are as follows: 1=yolk sac fry; 2=fry; 3=parr; 4=silvery parr; and 5=smolt. See table 9-1 for description of life stages.

[h] Tally nonsalmonid individuals that are not measured (after 30 individuals for that species have been measured).

Fry Emergence
Data Collection Form FISH-08-01

Date of Initial Survey: ______________________

Monitoring Team Member Names:[a] ______________
____

Date of Final Survey: ______________________

Monitoring Team Member Names:[a] ______________
____

Redd Identification Number:[b] ______________________

Stream Segment:[c] ______________________

Water Temperature Logger ID Number Corresponding to Redd: ______________________

GPS Identification Number (only for area upstream of Project area on Guadalupe River and for Los Gatos Creek):
____

Data Collected Immediately after Redd Is Observed

Redd Measurements[d] (measured to the nearest 0.1 foot) Upstream Edge of Redd Pit: ______________ Downstream Edge of Redd Pit: ______________ Downstream Edge of Tail Spill: ______________ Width of Redd Pit: ______________ Width of Tail Spill: ______________	Scour Chain Measurements Location of Chain along Cross Section (feet): ______________ Number of Exposed Links (after installation): ______________
Comments	

Data Collected Immediately after Redd Is Observed **and** after Monitoring Is Completed

	Initial Survey		Final Survey	
Feature	Rod Reading (0.1 foot) [e]	Distance along Cross Section[f]	Rod Reading (0.1 foot) [e]	Distance along Cross Section[f]
Benchmark		■		■
Stream bed near right edge of pit				
Deepest point of redd pit and distance from cross section				
Stream bed near left edge of pit				
Top of tail spill and distance from cross section				
Benchmark (second reading)		■		■

Scour Chain Measurements after Monitoring Is Completed

If Chain Is Exposed Number of Exposed Links: ______________	If Chain Is Buried Depth of Gravel Covering Chain: ______________ Number of Links above Vertically Oriented Links: ______
Comments	

Fry Emergence
Data Collection Form FISH-08-01

Redd Diagram[g]

[a] List first initial and last name of each member of the monitoring team for initial survey and final survey.

[b] Use the redd identification number given each redd during adult migration and spawning monitoring. For example, the first redd observed in water year 2001 would be 01-REDD-001.

[c] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; Guadalupe River; or Los Gatos Creek.

[d] These measurements are made relative to the cross section between the 2 monuments. The right bank monument is the 0 end of the cross section. Right and left banks are relative to a person facing downstream.

[e] Rod reading taken on the point being surveyed.

[f] Linear distance on measuring tape from the right bank monument.

[g] Label the following: the monuments at each end of the cross section, the cross section, the upstream edge of the redd pit, the downstream edge of the redd pit, the downstream edge of the redd tail spill, the location of the GPS reading (when taken), and the location of the chain.

Page ___ of ___

Fry Emergence
Data Collection Form FISH-08-02

Date: ______________________ Monitoring Team Member Names:[a] ______________________

Water Temperature Data Collected Every 2 Weeks

Logger Identification Number [b]	Logger Location (narrative)	Action? (logger installation, data download, or logger retrieval)	Time	Water Temperature (°F) [c]	Water Temperature Data Filename [d]	Comments

Redd Data Collected Every 2 Weeks

Redd Identification Number [e]	Redd Location (narrative)	Number of Exposed Links in Chain	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] The 6-digit serial number on the water temperature logger.

[c] Measured using a hand-held water temperature thermometer.

[d] Water temperature data filenames are assigned using the 6-digit serial number on the water temperature logger, underscore, and 6-digit date (2 digits each for year, month, and day). For example, the filename for data retrieved from water temperature logger 123456 on October 22, 2002, would be 123456_021022.

[e] Use the redd identification number given each redd during adult migration and spawning monitoring. For example, the first redd observed in water year 2001 would be 01-REDD-001.

Fry Emergence
Data Collection Form FISH-08-03

Date: ______________ Monitoring Team Member Names:[a] ____

Data Collected for Redds **Without Traps**

Redd Identification Number[b]	Stream Segment[c]	Time	Water Temperature (°F)[d]	Number of Fry Observed	Approximate Length of Fry (millimeters)	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] Use the redd identification given each redd during adult migration and spawning monitoring. For example, the first redd observed in water year 2001 would be 01-REDD-001.

[c] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; Guadalupe River above the Project area; Guadalupe Creek below Masson Dam; Guadalupe Creek above Masson Dam; Los Gatos Creek; Alamitos Creek; or Calero Creek.

[d] Measured using a hand-held water temperature thermometer.

Fry Emergence
Data Collection Form FISH-08-04

Date: ____________________________

Monitoring Team Member Names:[a] ____

Data Collected during Fry Emergence for Redds **With Traps**

Redd ID Number[b]	Stream Segment[c]	Time	Water Temperature (°F)[d]	Total Number of Fry Observed	Total Weight of All Fry (0.01 gram)	Life Stage Assessment		Comments
						Life Stage Assessment Code[e]	Number of Fry[f]	
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		
						1		
						2		

[a] List first initial and last name of each member of the monitoring team.

[b] Use the redd identification number given each redd during adult migration and spawning monitoring. For example, the first redd observed in water year 2001 would be 01-REDD-001.

[c] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; Guadalupe River above the Project area; Guadalupe Creek below Masson Dam; Guadalupe Creek above Masson Dam; Los Gatos Creek; Alamitos Creek; or Calero Creek.

[d] Measured using a hand-held water temperature thermometer.

[e] Life stage assessment codes are 1=yolk sac fry and 2=fry.

[f] Total number of fry for life stage assessment codes 1 and 2 must equal value entered under “Total Number of Fry.”

Page ___ of ___

Survival and Health and Vigor
Data Collection Form RIP-01

Date: ______________________________

Monitoring Team Member Names:[a] __________

____

____

Sampling Plot Identification Number: __________

____

Health and Vigor Numeric Rating

Numeric Rating	Narrative Rating	Foliage/Wood/Rootcrown Condition[a]
5	Excellent	Less than 5% of plant affected by cumulative symptoms of poor health
4	Very Good	6–25% of plant affected by cumulative symptoms of poor health
3	Good	26–50% of plant affected by cumulative symptoms of poor health
2	Fair	51–75% of plant affected by cumulative symptoms of poor health
1	Poor	Greater than 75% of plant affected by cumulative symptoms of poor health
0	Dead	

[a] After Daubenmire (1968) (modified).

Plant ID Number	5-Letter Species Code[b]	Plant Form (tree or shrub[c, d])	Health and Vigor Numeric Rating[e]			Comments
			Foliage	Wood	Root Crown	

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Vines are included in the shrub category (table F-1 of appendix F).

[d] The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

[e] Health and vigor numeric rating; see table at top right corner.

Page ___ of ___

Qualitative Assessment
Data Collection Form RIP-02

Date: ______________________

Monitoring Team Member Names:[a] ______________________________________

Riparian Vegetation Mitigation Planting Area:[b] ______________________________

5-Letter Species Code[c]	Problem Description[d]	Specific Location[e] (narrative)	Ground-Level Digital Image Number (if applicable)

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Segment 1A, Segment 1B, or Segment 2.

[c] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F lists 5-letter species codes for planted trees and shrubs only). If the problem does not apply to a species or group of species, record "general."

[d] Indicate problems that may affect the area's ability to provide riparian vegetation habitat (e.g., insects, herbivory, plant die-off, unhealthy foliage, vandalism, high nonnative cover, and/or maintenance issues, such as irrigation problems, weed control, and plant protection).

[e] If the problem does not have a specific location, record "general."

Natural Recruitment
Data Collection Form RIP-03

Natural Recruitment Abundance Scores

Abundance Score	Narrative Rating	Number of Natural Recruits (as a range)
1	Rare	1–5
2	Common	6–50
3	Abundant	>50

Date: ______________________

Monitoring Team Member Names:[a] ______________________________________

Sampling Plot Identification Number: ____________________________________

5-Letter Species Code[b]	Abundance Running Tally	Abundance Score[c]	Recruitment Mechanism	Characteristics Influencing Recruitment	General Location/Comments
Evidence of seed production on planted trees and shrubs (e.g., seeds, seed pods, acorns, fruits, and nuts):					

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Abundance score: see table at top right corner.

Native and Nonnative Vegetative Cover
Line Intercept Method Data Collection Form RIP-04
(Monitoring Years 4, 5, and 10)

Date: ______________________________ Line Transect Number: ___________________________________

Monitoring Team Member Names:[a] ________ Line Transect Start Point: _________________________________

___________________________________ Line Transect End Point: __________________________________

___________________________________ Side of Secondary Channel (east or west; only for transects 3–12 and 30–34):
____

Tree: 5-Letter Species Code(s)[b]	Shrub: 5-Letter Species Code(s)[b, c]	Start of Cover (to nearest 0.5 foot)	End of Cover (to nearest 0.5 foot)
Comments:			

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F). When no cover intersects the line transect, record "none."

[c] Vines and species with an undetermined growth form are included in the shrub category (table F-1 in appendix F).

Page ___ of ___

Nonnative Species Cover
Visual Estimation Method Data Collection Form RIP-05
(Monitoring Years 1–5)

Date: ____________________________

Monitoring Team Member Names:[a] ____________

____

____

Riparian Vegetation Mitigation Planting Area:[b] ________

____

Cover Class by Visually Estimated Percentage of Relative Cover[c]

Cover Class	Visually Estimated Relative Cover (%)
1	<5
2	6–15
3	16–50
4	51–75
5	>75

5-Letter Species Code[d]	Area(s) of Concentration	Cover Class[e]

Total percentage of cover and cover class for all nonnative tree and shrub species (including giant reed):

Comments:

---

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Segment 1A, Segment 1B, or Segment 2.

[c] Relative cover is the percentage of the total vegetative cover that consists of a particular plant species or vegetation category. Relative cover does NOT include bare ground.

[d] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[e] Cover class: see table at top right corner.

Tree Height and Basal Area Data Collection Form RIP-06

Date: ______________________________

Monitoring Team Member Names:[a] ______________________________

____

____

Sampling Plot Identification Number **OR**
Reference Site Identification Number: ______________________________

Photo Point Direction (circle one): North South East West

Photo Point GPS Coordinates: ______________________________

Ground-Level Digital Image Direction (to nearest 1°): ______________________________

Ground-Level Digital Image Number: ______________________________

Plant ID Number	5-Letter Species Code[b]	Tree Height				Basal Area	Comments
		Stadia Rod Height (feet)	Clinometer Readings			Stem Diameter(s) at Breast Height (dbh) (inches)[c]	
			Angle to Tree Top (°)	Angle to Tree Base (°)	Distance (feet)		

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Diameter at breast height is the point on the main stem 4.5 feet from the ground where the tree's diameter measurement is taken. Record diameter to nearest 0.1 inch for all trees greater than 2 inches in diameter. Do not record diameter for multistemmed tree species less than 8 feet tall. For multistemmed tree species greater than 8 feet tall, measure the diameter of each stem with a diameter greater than 2 inches and record the diameters. Separate multiple entries in the column with a comma.

Tree Height and Basal Area
Data Collection Form RIP-07
(Bitterlich Method)

Date: ___________________________________

Photo Point Direction (circle one): North South East West

Monitoring Team Member Names:[a] ____________

Photo Point GPS Coordinates: _________________________________

____

Photograph Direction (to nearest 5°): ___________________________

____

Sampling Plot Identification Number: __________

5-Letter Species Code[b]	Basal Area Factor (BAF)[c]	Total Basal Area

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Basal area factor (BAF) should be indicated on your gauge.

Page ___ of ___

Survival and Health and Vigor
Data Collection Form SRA-01

Date: ____________________

Monitoring Team Member Names:[a] ____________
____
____

Sampling Plot Identification Number: ____________
____

Health and Vigor Numeric Rating

Numeric Rating	Narrative Rating	Foliage/Wood/Rootcrown Condition[a]
5	Excellent	Less than 5% of plant affected by cumulative symptoms of poor health
4	Very Good	6–25% of plant affected by cumulative symptoms of poor health
3	Good	26–50% of plant affected by cumulative symptoms of poor health
2	Fair	51–75%% of plant affected by cumulative symptoms of poor health
1	Poor	Greater than 75% of plant affected by cumulative symptoms of poor health
0	Dead	

[a] After Daubenmire (1968) (modified).

Plant ID Number	5-Letter Species Code[b]	Plant Form (tree or shrub[c, d])	Health and Vigor Numeric Rating[e]			Comments
			Foliage	Wood	Root Crown	

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Vines are included in the shrub category (table F-1 of appendix F).

[d] The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

[e] Health and vigor numeric rating; see table at top right corner.

Page ___ of ___

Qualitative Assessment
Data Collection Form SRA-02

Date: ______________________

Monitoring Team Member Names:[a] _____________________________________

SRA Cover Vegetation Mitigation Planting Area:[b] __________________________

5-Letter Species Code[c]	Problem Description[d]	Specific Location[e] (narrative)	Ground-Level Digital Image Number (if applicable)

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, or 3A; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F lists 5-letter species codes for planted trees and shrubs only). If the problem does not apply to a species or group of species, record "general."

[d] Indicate problems that may affect the area's ability to provide riparian vegetation habitat (e.g., insects; herbivory, plant die-off, unhealthy foliage, vandalism, high nonnative cover, and/or maintenance issues, such as irrigation problems, weed control, and plant protection).

[e] If the problem does not have a specific location, record "general."

Natural Recruitment
Data Collection Form SRA-03

Date: ______________________

Monitoring Team Member Names:[a] ______________________________________

Sampling Plot Identification Number: ____________________________________

Natural Recruitment Abundance Scores[c]

Abundance Score	Narrative Rating	Number of Natural Recruits (as a range)
1	Rare	1–5
2	Common	6–50
3	Abundant	>50

5-Letter Species Code[b]	Abundance Running Tally	Abundance Score[c]	Recruitment Mechanism	Characteristics Influencing Recruitment	General Location/Comments
Evidence of seed production on planted trees and shrubs (e.g., seeds, seed pods, acorns, fruits, and nuts):					

[a] List first initial and last name of each member of the monitoring team.

[b] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[c] Abundance score: see table at top right corner.

Nonnative Vegetative Cover
Visual Estimation Method Data Collection Form SRA-04
(Monitoring Years 1–5)

Cover Class by Visually Estimated Percentage of Relative Cover[c]

Cover Class	Visually Estimated Relative Cover (%)
1	<5
2	6–15
3	16–50
4	51–75
5	>75

Date: ____________________

Monitoring Team Member Names:[a] ____________________

____

____

SRA Cover Vegetation Mitigation Planting Area:[b] ____________________

5-Letter Species Code[d]	Area(s) of Concentration	Cover Class[e]

Total percent cover and cover class for all nonnative tree and shrub species (including giant reed):

Comments:

---

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, or 3A; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Relative cover is the percentage of the total vegetative cover that consists of a particular plant species or vegetation category. Relative cover does NOT include bare ground.

[d] Consists of the first 2 letters of the genus name and the first 3 letters of the species name (e.g., the species code for *Salix exigua* is SAEXI) (table F-1 in appendix F).

[e] Cover class: see table at top right corner.

Page ___ of ___

Shaded Stream Surface
Data Collection Form SRA-05

Date: ______________________

Monitoring Team Member Names[a]: ______________________________________

____

Sampling Plot Identification Number: ______________________________________

Distance From Sampling Plot's Downstream End[b]	Wetted Channel Width (feet)	Comments
0 feet		

[a] List first initial and last name of each member of the monitoring team.

[b] Measure the width of the wetted channel at the downstream end of the sampling plot (beginning of sampling plot), the upstream end of the sampling plot (end of sampling plot), and at least 1 additional location for each 50 feet of stream length along the sampling plot (the measurements should be taken at evenly spaced intervals along the length of the sampling plot). Some sampling plots are divided into noncontinuous sections. Stream width measurements for these sampling plot sections follow the same protocol as for a complete sampling plot. For example, a 200-foot sampling plot or segment would have 5 width measurements: 1 measurement at the beginning, 1 measurement at the end, and additional measurements at 50 feet, 100 feet, and 150 feet upstream from the downstream end of the sampling plot. A 130-foot sampling plot section would have 4 width measurements: 1 measurement at the beginning, 1measurement at the end, and additional measurements at 43 feet and 86 feet upstream from the downstream end of the sampling plot.

Page ___ of ___

Bank Stability
Data Collection Form SRA-06

Date: ______________________

Stream Segment[b]: ____

Monitoring Team Member Names[a]: ____________________________________

Total Natural Bank Length of Stream Segment (natural bank length [in feet](2):

____

____

Bank Segment Identification Number[c]	Side of Bank (left or right)[d]	Distance to Surface (feet) (vertical, horizontal)[e]	Bank Type (unstable or potentially unstable)[f]	GPS Identification Number[g]	Bank Segment Length (feet)	Comments / Ground-Level Digital Image Number (if applicable)

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Number bank segments sequentially for each water year, using the following naming convention: "WY-BANK-Segment #," where "WY" is the last 2 digits of the water year (e.g., "01" for 2001) and "Segment #" is a 3-digit segment number (e.g., "001" for first bank segment and "002" for second). For example, the first bank segment in water year 2001 would be 01-BANK-001.

[d] Right and left banks are relative to a person facing downstream.

[e] Visually estimate the distance to the adjacent geomorphic surface from the water surface level.

[f] **Unstable banks** have less than 75% cover of live plants and/or other stability elements or have 1 or more instability elements (unstable banks are often bare or nearly bare banks composed of noncohesive soils that are susceptible to fluvial erosion; particle size may vary depending on bank material).
Potentially unstable banks have 75% or more cover but 1 or more instability elements (exception: classify the bank as stable if bank height is the only instability element).

[g] Take 1 GPS recording at downstream end of each unstable or potentially unstable bank segment.

Instream Cover
Data Collection Form SRA-07

Date: ____________________________________

Stream Segment:[b] ____________________________________

Monitoring Team Member Names:[a] ____________

____

____

Transect Band Identification Number:[c] ______________________

Secchi Tube Reading: ____________ (millimeters) at: ______ (time)

Wetted Channel Width: LWE[d]__________ – RWE[d]_______= ______

Field-Collected Data (Do Not Enter into GEMS)

Distance from RWE[d] (feet)		Instream Cover Type						Comments
Start Cover Feature	End Cover Feature	Undercut Bank[e]	Instream Woody Material[f]	Boulders, Rocks[g]	Herbaceous Vegetation[h]	Riprap[i]	None	

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, 3A, 3B, or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Number transect bands sequentially for each water year, using the following naming conventions: “WY-ICVR-Transect #,” where “WY” is the last 2 digits of the water year (e.g., “01” for 2001) and “Transect #” is a 3-digit transect number (e.g., “001” for first transect band and “002” for second). For example, the first transect band in water year 2001 would be 01-ICVR-001.

[d] LWE = left water’s edge; RWE = right water’s edge. Left and right banks are relative to a person facing downstream.

[e] Greater than 4 inches deep.

[f] Includes roots, logs, and debris piles greater than 155 square inches, or 1.1 square feet, in surface area.

[g] Greater than 8 inches in diameter.

[h] Nonwoody submergent, emergent, and/or flooded terrestrial vegetation.

[i] Concrete, rock, or other artificial hard cover that has clearly been introduced into the stream channel through human activities.

Data Transformed to Account for Overlap (Enter into GEMS)

Distance from RWE (feet)		Instream Cover Type or Group (if multiple cover types overlap, check more than 1 cover type)						Comments
Start Cover Group	End Cover Group	Undercut Bank	Instream Woody Material	Boulders, Rocks	Herbaceous Vegetation	Riprap	None	

Instream Cover
Data Collection Form SRA-07

Data Transformed to Account for Overlap (Enter into GEMS), Continued

Distance from RWE (feet)		Instream Cover Type or Group (if multiple cover types overlap, check more than 1 cover type)						
Start Cover Group	End Cover Group	Undercut Bank	Instream Woody Material	Boulders, Rocks	Herbaceous Vegetation	Riprap	None	Comments

Channel Bottom Stability
Data Collection Form SRA-08

Date: ______________________________

Monitoring Team Member Names:[a] __________

____

____

Cross-Section Identification Number: ______________________

Known-Elevation Point: ______________________

Height of Instrument[b]: ______________________

Left Bank Monument Station:[c,d] ______________________

Right Bank Monument Station:[c,d] ______________________

Measurements **to Left of** Base of Left Bank Monument and **to Right of** Base of Right Bank Monument

Backsight Reading[e]	Station[d]	Foresight Reading[f]	Elevation[g]	Location of Important Features/Comments[h]

Measurements **between** Base of Left Bank Monument and Base of Right Bank Monument

Station[d]	Foresight Reading[f]	Elevation[g]	Location of Important Features/Comments[h]

Channel Bottom Stability
Data Collection Form SRA-08

Measurements **between** Base of Left Bank Monument and Base of Right Bank Monument, Continued

Station[d]	Foresight Reading[f]	Elevation[g]	Location of Important Features/Comments[h]

Note: All readings must be accurate to within 0.2 foot.

[a] List first initial and last name of each member of the monitoring team.

[b] Height of instrument = elevation of the line of sight of the level.

[c] Left and right banks are relative to a person facing downstream.

[d] Station = linear distance on tape from left bank monument.

[e] Backsight reading = rod reading taken at point of known elevation.

[f] Foresight reading = rod reading taken on point whose elevation is to be determined.

[g] Elevation = elevation of backsight and foresight.

[h] Note the location of important features, including the top and bottom of the banks, the west and east edge of water, the deepest point in the channel, and the top and base of the monuments.

Page ___ of ___

Measured Water Temperature
Data Collection Form WATER-01

Date: ____________________________ Time Standard Used (Pacific Standard Time or Daylight Savings Time): ____

Monitoring Team Member Names:[a] ____

Logger ID Number [b]	Logger Location	Action (placement, retrieval, or data download)	Time	Water Temperature (°F) [c]	Water Temperature Data Filename	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] The 6-digit serial number on the water temperature logger.

[c] Measured using a hand-held water temperature thermometer.

Page ___ of ___

Solar Radiation
Data Collection Form WATER-02

Date: ______________________

Monitoring Team Member Names:[a] ____

Model Segment:[b] __________________________

Shaded Area Identification Number [c]	Shade Type [d]	15-Second Integrated Light Meter Readings in Shaded Area (watts/meter^2)					Full Sun Light Meter Reading (watts/meter^2)	Time	Approximate Length Walked (feet)	Comments (estimated tree height and canopy diameter, dominant tree species or type, and distance of tree trunks from channel)

---

[a] List first initial and last name of each member of the monitoring team.

[b] Model segments 5 and 6 cover Guadalupe Creek; model segments 30–37 cover Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass; and model segment 38 covers Reach A.

[c] Recorded on the aerial photograph.

[d] Terrestrial vegetation, aquatic vegetation, building, or topography shade.

Page ___ of ___

Aquatic Vegetation Growth
Data Collection Form WATER-03

Date: ______________________

Monitoring Team Member Names:[a] ____________________________________

____

Model Segment:[b] __________________________

Aquatic Vegetation Line Transect Identification Number:[c] ___________________

Description of Transect Location: _____________________________________

LWE:[d] ____

RWE:[d] ____

Distance from LWE[d] (feet)				
Start Aquatic Vegetation[e]	End Aquatic Vegetation[e]	Aquatic Vegetation Description	Relative Stream Flow Velocity[f]	Comments

[a] List first initial and last name of each member of the monitoring team.

[b] Model segments 5 and 6 cover Guadalupe Creek.

[c] Use the following alpha-numeric naming convention to label each aquatic vegetation line transect: water year, 4-letter abbreviation for aquatic vegetation line transect, and a consecutive number for each gravel bed, beginning with 001. For example, the first aquatic vegetation line transect for WY 2001 would be labeled 01-AVLT-001.

[d] LWE = left water edge; RWE = right water edge. Left and right banks are relative to a person facing downstream.

[e] Aquatic vegetation shade is the stream surface covered by rooted vegetation that extends above the water surface (e.g., floating water primrose [*Ludwigia peploides*]); it does not include submerged or floating vegetation that is not rooted in the channel bottom or banks (e.g., duckweed [*Lemna* spp.]).

[f] Stream flow relative to the flow center of channel (e.g., same, slow, much slower).

Page ___ of ___

Stream Channel Geometry
Data Collection Form WATER-04

Date: ______________________

Monitoring Team Member Names:[a] ____

Model Segment:[b] ____________

Stream Flow at SCVWD[c] gages 23B and 50 (for Guadalupe River surveys) or SCVWD Gage 17 (for Guadalupe Creek surveys):

____

Cross-Section Identification Number[d]	Wetted Channel Width	Location of 100-Foot Measurement[e]	Depth at 2-Foot Intervals across Wetted Channel Width (0.1 foot)[f]																
			0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32

Comments[g]:

---

[a] List first initial and last name of each member of the monitoring team.

[b] Model segments 5 and 6 cover Guadalupe Creek; model segments 30–37 cover Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass; and model segment 38 covers Reach A.

[d] SCVWD = Santa Clara Valley Water District.

[e] Number cross sections sequentially for each water year using the following naming convention: “WY-GEOM-CrossSection#,” where “WY” is the last 2 digits of the water year (e.g., “01” for 2001) and “CrossSection#” is a 3-digit cross-section number (e.g., “001” for first location and “002” for second location). For example, the first cross section in water year 2001 would be 01-GEOM-001.

[e] Location where the 100 feet between this transect and the previous transect was measured (i.e., left bank, right bank, or in the stream). Right and left banks are relative to a person facing downstream.

[f] If river is more than 32 feet wide, use 2 rows on data collection form. If river is less than 10 feet wide, take measurements at 1-foot intervals and record 2 numbers in each cell.

[g] If more than approximately 5% of the wetted channel width contains stagnant water, note the approximate proportion of the wetted channel width that contains stagnant water.

Page ___ of ___

Stream Flow Measurements
Data Collection Form WATER-05

Date: ____

Monitoring Team Member Names:[a] ________________

____

Stream Segment:[b] ______________________________

Channel Width: ________________________________

Model Segment:[c] ______________________________

Location in Model Segment (U, D, or G):[d] ___________

General Description of Measurement Site
(stream characteristics and location): ___________________

____

____

Notes on Upstream Changes in Flow
(i.e., water observed entering or leaving the river): ________

____

____

Tape Distance (feet)[e]	Depth (feet)	Velocity (feet per second)[f]			Comments
		0.2 (depth	0.8 (depth	0.6 (depth	

[a] List first initial and last name of each member of the monitoring team.

[b] Indicate Reach A; Segments 1, 2, 3A, 3B or 3C; Woz Way to Park Avenue Bypass; or Guadalupe Creek.

[c] Model segments 5 and 6 cover Guadalupe Creek; model segments 30–37 cover Segments 1, 2, 3A, 3B, and 3C and Woz Way to Park Avenue Bypass; and model segment 38 covers Reach A.

[d] U = upstream end of the temperature model segment; D = downstream end of the temperature model segment; G = at a gage.

[e] The 0 should be at the right water's edge. Right is relative to a person facing downstream.

[f] If depth is greater than 2.5 feet, measure velocity at 0.2 and 0.8 of the total depth. Otherwise, measure velocity at 0.6 of the total depth.

Appendix E

Approach to Locating Permanent, Field-Marked Sampling Plots and Line Transects Identified in the February 2001 Guadalupe River Project Mitigation and Monitoring Plan

Appendix E

Approach to Locating Permanent, Field-Marked Sampling Plots and Line Transects Identified in the February 2001 Guadalupe River Project Mitigation and Monitoring Plan

E.1 Introduction

This appendix describes the approach used for selecting and locating permanent, field-marked sampling plots and line transects referenced in the February 2001 Guadalupe River Project (Project) Mitigation and Monitoring Plan (MMP). The selection of permanent sampling plots and line transects occurred in two phases. Phase 1, which occurred in July 2001, included selecting and locating permanent sampling plots and line transects in Reach A, Segments 1–3, and the Woz Way to Park Avenue Bypass. Phase 2, which occurred in September 2002, included selecting and locating permanent sampling plots along Guadalupe Creek.

The selection approach incorporated guidance provided by the

- MMP;
- analysis of the planting areas and planting methods in Reach A; Segments 1, 2, and 3A; and the Woz Way to Park Avenue Bypass;
- analysis of the Guadalupe Creek Restoration Project planting plan (Jones & Stokes and Northwest Hydraulic Consultants 2000); and
- results of site visits on October 26, 2000, and September 16, 2002.

Three monitoring components identified in the MMP require permanent, field-marked sampling plots or line transects:

- riparian vegetation (in Segments 1 and 2),
- shaded riverine aquatic (SRA) cover (in Segments 1–3A, Woz Way to Park Avenue Bypass, Reach A, and Guadalupe Creek), and
- channel bottom stability (in Segments 2 and 3B and the Woz Way to Park Avenue Bypass).

E.2 Riparian Vegetation

A total of 21.0 acres of riparian vegetation was planted in bench-cut areas along the west side of the Guadalupe River in Segments 1 and 2 (figure E-1, pages 7–12). Approximately 4.0 acres were planted in Segment 1 in 1994 and winter 1998–1999. The remaining 17.0 acres were planted in Segment 2 during winter 1998–1999. Valley oak (*Quercus lobata*) acorns were planted in both segments during fall and winter 1999–2000. Riparian plantings consisted of native riparian trees (with a planting density of 200–400 trees per acre) and shrubs (with a planting density of 100–200 shrubs per acre).

The MMP requires that 18 randomly located 50- by 50-foot sampling plots and 50 line transects be established in the riparian vegetation planting areas in Segments 1 and 2. A sampling plot and line transect layout was previously established by Assegued & Associates, the U.S. Army Corps of Engineers' (Corps') revegetation contractor, for these planting areas. The sampling plots and line transects were used to monitor riparian vegetation plantings in 1999 and 2000 under an earlier monitoring program.

These previously established riparian vegetation sampling plots and line transects were evaluated to determine whether they could be used to implement the MMP. When possible, existing sampling plots and line transects were used to increase efficiency and consistency with previous monitoring. In many cases, the existing riparian vegetation sampling plots and line transects were found to be suitable for monitoring indicators described in the MMP. However, some modifications were made based on existing or proposed site conditions. The justification for modifying the existing riparian vegetation sampling plots and line transects is described in the following sections.

In addition, the MMP requires that basal area reference plots be established for monitoring the tree basal area indicator.

E.2.1 Sampling Plots

E.2.1.1 Previously Existing Sampling Plot Layout

The previously existing sampling plot layout established by Assegued & Associates was reviewed in the office and verified in the field during the October 26, 2000, site visit. Results of this review and verification are listed below.

- Twenty-one 50- by 50-foot, previously existing sampling plots were located and marked on the ground. The corner of each sampling plot was marked in the field. The markers consisted of T-posts painted red and topped with an orange cap.

- All previously existing sampling plots were located within the riparian vegetation areas planted in winter 1998–1999.
- To set up the 50- by 50-foot grid system that was the basis for the previously existing sampling plot locations, end points of every other grid line perpendicular to the river were established on the ground and marked with a T-post driven into the ground. Most T-posts had an aluminum tag with a post number corresponding to a number on a map of plot locations.
- The end points of the grid lines farthest from the river were marked with a large nail driven into the nearest paved pathway at 100-foot intervals. This nail was located between the asphalt and the narrow strip of concrete bordering the pathway on the side facing the river. The immediate area around each nail was marked with orange spray paint.

A map prepared by Assegued & Associates showed the location of the 20 previously existing sampling plots. At the time of the October 26, 2000, site visit, 19 of the 20 sampling plots shown on the map were marked in the field. One sampling plot noted on the map could not be located in the field. This plot may have been eliminated because the planting area at this location was too narrow to accommodate a full plot. Two additional sampling plots not shown on the Assegued & Associates map were also marked in the field.

Sampling plot locations marked in the field by Assegued & Associates appeared to have been selected using random methods, as required in the MMP, and appeared to be representative of the overall status of the planted riparian vegetation. The 18 permanent sampling plot locations required by the MMP (figure E-1, pages 7–11) were randomly selected from the 21 plots already marked in the field by Assegued & Associates. Because the previously existing sampling plots were used, results of the earlier monitoring program can be compared to the monitoring results compiled after the implementation of the MMP.

An additional two sampling plots were identified in Segment 1A. These plots were randomly selected from all the possible plots created by the 50- by 50-foot grid system. Additional plots were selected in Segment 1A because none of the 18 plots selected from the original 21 plots marked in the field were in Segment 1A. Because Segment 1A was planted 5 years before Segments 1B and 2, it is important to monitor it separately from the other segments.

E.2.2 Tree Basal Area Reference Plots

Tree basal area reference plots will be established, and tree basal area data will be collected simultaneously in these reference plots with basal area data collected in the riparian vegetation sampling plots. Between 5 and 10 small reference plots will be established. Reference plots must

- be in stands that are mature, preferably approximately 40 years old, and relatively homogenous;
- measure at least 15 by 45 feet;
- be oriented with their long axis parallel to the channel; and
- reflect a relatively drought-tolerant composition of riparian vegetation.

E.2.3 Line Transects

Beginning in monitoring year 4, long-term evaluation of vegetative cover is monitored along 50 randomly chosen parallel line transects that traverse the planting areas. Cover data are collected using the line-intercept method. The MMP specifies that the line transect locations be chosen from all possible parallel lines 50 feet apart that can be located approximately perpendicular to the river within the planted area. In addition, potential transects should traverse at least 50 feet of the planted area. Using the same 50-by-50-foot grid system established by Assegued & Associates to locate the riparian vegetation sampling plots, Jones & Stokes determined that 96 potential transect lines met these criteria.

A series of 32 parallel line transects had been selected by Assegued & Associates and marked with a T-post labeled with a small aluminum tag bearing a line number. These transects appeared to have been selected from all possible parallel lines 100 feet apart (or every other line of the previously established 50- by 50-foot grid system). Two of these previously selected transect lines in the vicinity of the Hedding Street Bridge crossing were located outside the riparian vegetation mitigation planting area.

Jones & Stokes selected 30 of the 32 previously existing line transects to be used for vegetative cover monitoring, which allows for comparisons between monitoring results obtained before and after implementation of the MMP. Two of the previously existing transects were not used because they were located outside the currently planted areas. Twenty additional transects were randomly chosen from among the 66 remaining potential transect locations, for a total of 50 line transects (figure E-1, pages 7–11).

E.3 SRA Cover

The MMP states that 20% of the SRA cover planting area will be sampled using 200-foot sampling plots. Approximately 23,677 linear feet of SRA cover mitigation has been planted (or, in the case of Segment 3A, is proposed to be planted), so a total of twenty-four 200-foot sampling plots are required by the MMP. SRA cover mitigation has been planted in the following locations:

- approximately 7,780 linear feet at the Reach A mitigation site;

- approximately 2,574 linear feet in Segments 1–3 (including 410 linear feet proposed to be planted in fall 2004 in Segment 3A);
- approximately 277 linear feet in the Woz Way to Park Avenue Bypass; and
- approximately 13,046 linear feet at the Guadalupe Creek mitigation site.

The MMP states that SRA cover plantings should be divided into 1,000-foot segments, with a single 200-foot-long plot randomly located within each 1,000-foot segment. Twelve SRA cover sampling plots were located in the Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass mitigation sites (which constitute a total of 10,631 linear feet) (table E-1). Although there are only eleven 1,000-foot segments of SRA cover mitigation in the Reach A, Segments 1–3, and Woz Way to Park Avenue Bypass mitigation sites, an additional sampling plot was added to Segment 2 to ensure that one of the biotechnically stabilized banks was sampled. An additional 12 sampling plots were located at the Guadalupe Creek mitigation site (which constitutes approximately 13,046 linear feet). Although there are thirteen 1,000-foot segments of SRA cover mitigation in the Guadalupe Creek mitigation site, only 12 sampling plots were established because initial measurements indicated there were only approximately 12,000 feet of SRA cover mitigation. Because many of the individual planting areas were shorter than 1,000 linear feet, the 1,000-foot segments were frequently discontinuous, spanning unplanted areas. Some of the selected sampling plots were therefore divided, with sections in adjacent planted areas.

SRA cover sampling plots were identified along the Guadalupe River and Guadalupe Creek during the October 26, 2000, and September 16, 2002, site visits. During the October 26, 2000, site visit, SRA cover sampling plots in Reach A, Segments 1–3, and the Woz Way to Park Avenue Bypass were observed in the field to verify their suitability for monitoring.

SRA cover sampling plots were not identified for Guadalupe Creek during the October 26, 2000, site visit because revegetation activities had not yet been completed. The implementation phase of the Guadalupe Creek Restoration Project was significantly completed in spring 2002. Permanent SRA cover sampling plots were randomly selected in the office and then observed in the field to verify their suitability for monitoring during the September 16, 2002, site visit.

E.3.1 Methods for Establishing SRA Cover Sampling Plots along the Guadalupe River

To calculate the 1,000-foot SRA cover planting site segments specified in the MMP, the linear feet of SRA cover planting sites along the Guadalupe River were summed, beginning at the downstream end of Reach A (Site SRA PA-1) (figure E-1, page 1). SRA cover planting sites were summed beginning with locations on the west bank and continuing with locations on the east bank. Linear distances were stratified according to differences in planting method and, when possible, planting time. Therefore, contiguous linear distances for the unrestricted planting areas in Reach A were tabulated separately from the restricted planting areas in Reach A. (Restricted planting areas contain only a single row of planted trees because of water conveyance issues). In addition, linear distances for the pilot planting sites in Reach A, which were planted in winter 1998–1999 (figure E-1, pages 2–6), were tabulated separately from the sites in Reach A that were planted in winter 2000–2001. Seven SRA cover sampling plots were located in Reach A.

One SRA cover sampling plot was located in Segment 1, three were located in Segment 2, one was located in the Woz Way to Park Avenue Bypass, and one will be located in Segment 3A when SRA cover mitigation planting in that segment is complete. Even though planting times in Segments 1, 2, and 3 varied, it was impractical to stratify monitoring site selection by planting time because of the small sizes of the planting sites. The 200-foot sampling plots were randomly located within each of the 8 complete 1,000-foot segments, based on a number between 1 and 800 selected from a random-number table. The most upstream segment for each of four categories (i.e., unrestricted site planted in winter 2000–2001, unrestricted pilot planting area site planted in winter 1998–1999, restricted site planted in winter 2000–2001, and restricted pilot planting area site planted in winter 1998–1999), contained less than 1,000 linear feet of planted vegetation. Three SRA cover sampling plots were randomly allocated to these 4 shorter segments, using a random method weighted by the length of each segment. Placement of the 200-foot sampling plot within the 3 selected segments that were less than 1,000 feet long was based on a random-number table. A fourth SRA cover sampling site was identified in Segment 2. This sampling site was located at a biotechnical bank stabilization site that was constructed in fall 2001. This site was selected as a representative sampling plot to evaluate the survival and health and vigor of mitigation plantings located in similar structures in the Project area. The sampling plot in Segment 3A will be identified when SRA cover mitigation has been planted in that segment.

Two other criteria were also used to select sampling plot locations. First, if the random number resulted in a sampling plot being chosen on the east bank that overlapped with plots already chosen on the west bank (covering the same river mile segment and same shaded stream surface area), a new number was selected. Second, if the random number resulted in a sampling plot that extended across sections scheduled to be planted at different times, a new number was selected.

The location for sampling plot 12 (in the Woz Way to Park Avenue Bypass) (figure E-1, page 18) includes two sites planted at different times. Because of the short length of planting sites in this area, it was difficult to randomly locate a 200-foot monitoring plot that met all the above criteria.

The total linear feet of SRA cover planting sites and the number of sampling plots for each category are summarized in table E-1. The SRA cover sampling plot locations, listed from downstream to upstream, are identified in table E-2 and on figure E-1.

E.3.2 Methods for Establishing SRA Cover Sampling Plots along Guadalupe Creek

To calculate the 1,000-foot SRA cover planting site segments specified in the MMP, the linear feet of SRA cover planting sites along Guadalupe Creek were summed, beginning at the downstream end of the Guadalupe Creek mitigation planting area. The SRA planting sites were identified on the as-built drawings. The SRA cover planting sites were summed beginning with locations on the north bank and continuing with locations the south bank. Because a variety of planting methods were implemented along Guadalupe Creek, often in relatively small patches, the linear distances were not stratified according to differences in planting method. Therefore, most of the planting areas were contiguous linear distances that consisted of various planting methods. Twelve 200-foot sampling plots were randomly located within the thirteen 1,000-foot segments, based on a number between 1 and 800 selected from a random-number table. Six SRA cover sampling plots were randomly allocated on both the north and south banks.

Table E-1. Summary of SRA Cover Planting Type Categories for Plantings along the Guadalupe River and Guadalupe Creek

Planting Type	Total Planting Area (linear feet)	Number of Sampling Plots
Unrestricted regular planting	18,848	21
Unrestricted pilot planting	900	1
Restricted regular planting	3,329	2
Restricted pilot planting	600	0
Total	23,677	24

E.4 Channel Bottom Stability

The MMP (section 4.3.4.9) requires that up to 14 line transects be established in Segments 2 and 3 and the Woz Way to Park Avenue Bypass to monitor the elevation and stability of the channel bottom. The line transects will be surveyed each year between April and October for at least the first 10 years of the monitoring program to monitor channel bottom elevation. Changes in channel bottom elevation can affect bank stability, SRA cover vegetation, instream cover, water quality, and groundwater and surface water levels, which can affect overall SRA cover and water temperatures. The line transects are to be located in natural

Table E-2. Summary of SRA Cover Sampling Plot Locations in Reach A, Segments 1–3, the Woz Way to Park Avenue Bypass, and Guadalupe Creek

Sampling Plot	Location on East or West Bank	Stream Segment	Location Description
SRA PLOT-01	West	Reach A	In fall 2002, the downstream portion of this sampling plot was modified because plants were not within 15 feet of the low-flow channel. The downstream portion of the sampling plot was relocated to be immediately adjacent to the low-flow channel. Only natural recruitment, nonnative cover, shaded stream surface, and qualitative assessment monitoring will be conducted in SRA Plot-01 because the plants in the sampling plot are naturally recruited, not planted.
SRA PLOT-02	East	Reach A	Located in a pilot planting area.
SRA PLOT-03	East	Reach A	
SRA PLOT-04	West	Reach A	
SRA PLOT-05	East	Reach A	
SRA PLOT-06	West	Reach A	Located in a restricted planting area.
SRA PLOT-07	East	Reach A	Located in a restricted planting area.
SRA PLOT-08A, -08B, -08C, and -08D	West	Segment 1	Includes 4 SRA cover planting areas on the west bank of Segment 1.
SRA PLOT-09A, -09B, and -09C	West	Segment 2	Includes 3 SRA cover planting areas on the west bank of Segment 2.
SRA PLOT-10	West	Segment 2	Located within the biotechnical bank stabilization site upstream of Taylor Street Bridge.
SRA PLOT-11	TBD	Segment 3A	Will be located in Segment 3A after Project construction and mitigation installation in Segment 3A are complete. The sampling plot's location will be determined after mitigation installation is complete.
SRA PLOT-12A and -12B	West	Woz Way to Park Avenue Bypass	
SRA PLOT-13	South	Guadalupe Creek	
SRA PLOT-14	North	Guadalupe Creek	

Table E-2. Continued

Sampling Plot	Location on East or West Bank	Stream Segment	Location Description
SRA PLOT-15	North	Guadalupe Creek	
SRA PLOT-16	South	Guadalupe Creek	
SRA PLOT-17	North	Guadalupe Creek	
SRA PLOT-18A, -18B, and -18C	South	Guadalupe Creek	Includes 3 SRA cover planting areas on the south bank of Guadalupe Creek.
SRA PLOT-19	North	Guadalupe Creek	
SRA PLOT-20	South	Guadalupe Creek	
SRA PLOT-21A and -21B	South	Guadalupe Creek	Includes 2 SRA cover planting areas on the south bank of Guadalupe Creek.
SRA PLOT-22A and -22B	North	Guadalupe Creek	Includes 2 SRA cover planting areas on the north bank of Guadalupe Creek
SRA PLOT-23A, -23B, and –23C	North	Guadalupe Creek	Includes 3 SRA cover planting areas on the north bank of Guadalupe Creek
SRA PLOT-24A and -24B	South	Guadalupe Creek	Includes 2 SRA cover planting areas on the south bank of Guadalupe Creek

Note: TBD = to be determined.

channel areas that may potentially be affected by the downstream effects caused by Project components. Tentative locations for the line transects are proposed in the MMP.

During the October 26, 2000, site visit, the line transect locations proposed in the MMP were checked to determine whether the proposed locations would meet the goals of the MMP. In some cases, the proposed line transect locations were modified based on existing or proposed site conditions. The following sections summarize the results of the site visit and provide justification for the modification of some of the line transect locations identified in the MMP.

E.4.1 Segment 2

The MMP proposed that 1 line transect in Segment 2 be located 200 feet downstream of the Coleman Avenue Bridge, with 4 additional line transects located at 250-foot intervals downstream of the first line transect. During the site visit, the location of the first line transect was shifted downstream based on existing site conditions, which include hardscaped channel banks and bottom for approximately 300 feet downstream of the Coleman Avenue Bridge. Therefore, the first line transect in this segment was located approximately 320 feet downstream of the Coleman Avenue Bridge (figure E-1, page 11). The 4 additional line transects were located at intervals of approximately 160–340 feet downstream of the first line transect (figure E-1, pages 10 and 11).

E.4.2 Segment 3B

The MMP proposed that 1 line transect in Segment 3B be located approximately 200 feet downstream of the West Santa Clara Street Bridge, with up to 2 additional line transects at approximately 200-foot intervals downstream of the first line transect. All 3 of the proposed line transects were to be located upstream of the St. John Street Bridge. Based on the proposed Project design, which will result in the channel banks and bottom being hardscaped for approximately 325 feet downstream of the West Santa Clara Street Bridge, the first line transect in this segment was moved to a location approximately 350 feet downstream of the West Santa Clara Street Bridge (figure E-1, page 15). An additional line transect was located approximately 160 feet downstream of the first line transect (figure E-1, page 15). Because of the proposed modifications to line transect locations, only 2 line transects were located between the West Santa Clara Street and St. John Street Bridges.

Also in Segment 3B, the MMP proposed that 1 line transect be located approximately 200 feet downstream of the St. John Street Bridge, with up to 2 additional line transects at approximately 200-foot intervals downstream of the first line transect. All 3 of the proposed line transects were to be located upstream of the New Julian Street Bridge. Based on the proposed distances, the third line transect downstream of the St. John Street Bridge would be located under the New Julian Street Bridge. As a result, all 3 line transects were shifted upstream by 100 feet. The first line transect below the St. John Street Bridge was moved to a location approximately 50 feet downstream of the St. John Street Bridge. The 2 additional line transects were located at approximately 200-foot intervals downstream of the first line transect (figure E-1, page 14).

E.4.3 Woz Way to Park Avenue Bypass

In the Woz Way to Park Avenue Bypass, the MMP proposed that 1 line transect be located approximately 200 feet downstream of the Woz Way Bridge, with 2 additional line transects located at approximately 200-foot intervals downstream of the first line transect. During the site visit, Jones & Stokes modified the locations of these 3 line transects. The first line transect below the Woz Way Bridge was moved to a location approximately 150 feet downstream of the Woz Way Bridge. The 2 additional line transects were located at intervals of approximately 180–270 feet downstream of the first line transect (figure E-1, page 18).

E.5 References

Jones & Stokes and Northwest Hydraulic Consultants. 2000. *Guadalupe Creek restoration project.* Draft. April. Submitted to the Santa Clara Valley Water District, San Jose, CA. Sacramento, CA.

Appendix F

Plot Stem Maps for Riparian Vegetation and SRA Cover Sampling Plots

Appendix F
Plot Stem Maps for Riparian Vegetation and SRA Cover Sampling Plots

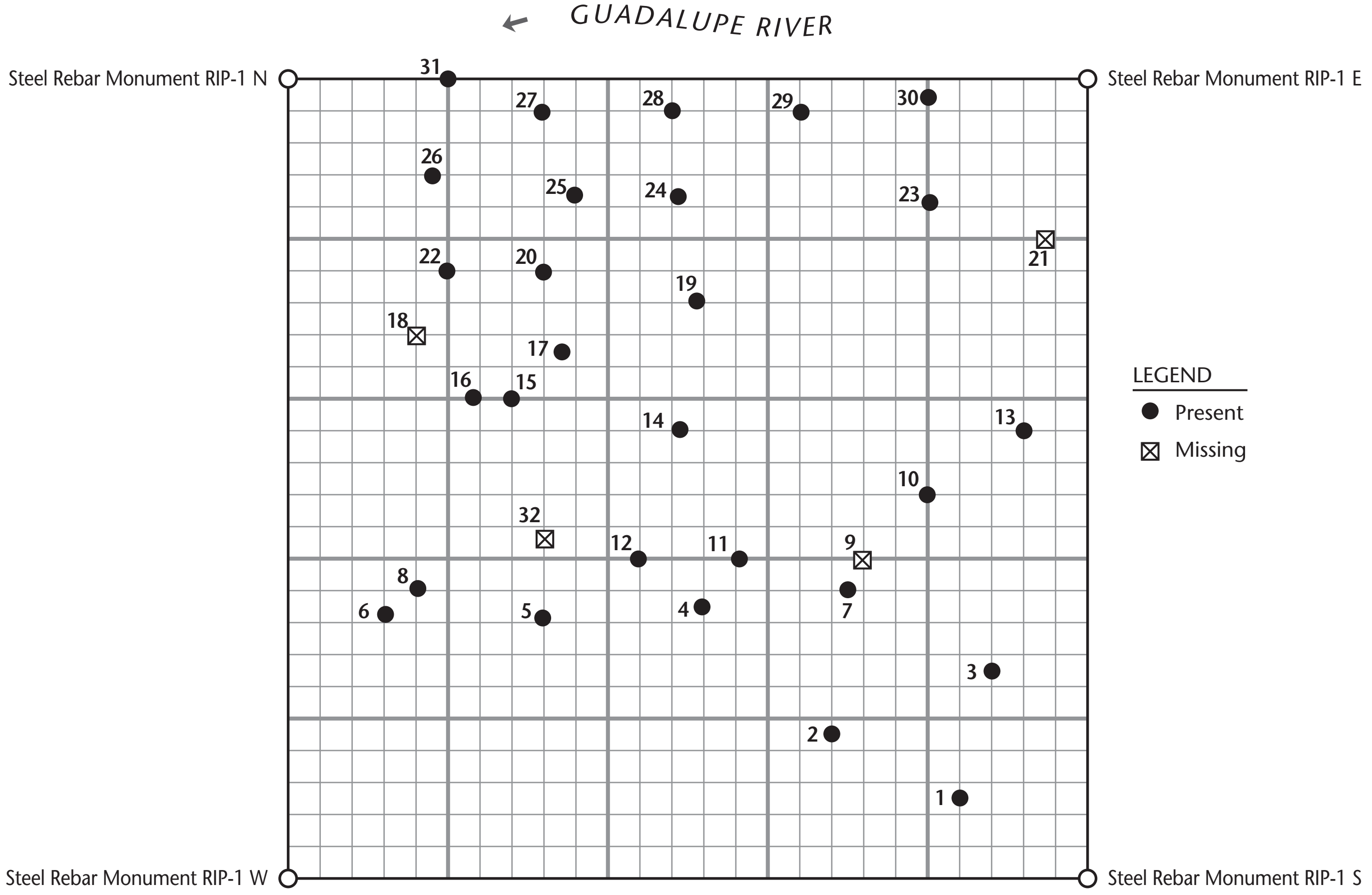
Table F-1. Trees and Shrubs Planted in Riparian Vegetation and SRA Cover Mitigation Planting Areas

Common Name	Scientific Name	5-Letter Species Code
Trees		
Box elder	*Acer negundo* var. *californicum*	ACNEG
California buckeye	*Aesculus californica*	AECAL
White alder	*Alnus rhombifoli*	ALRHO
Western sycamore	*Platanus racemosa*	PLRAC
Fremont cottonwood	*Populus fremontii* ssp. *fremontii*	POFRE
Black cottonwood	*Populus balsamifera* ssp. *Trichocarpa*	POBAL
Coast live oak	*Quercus agrifolia*	QUAGR
Blue oak	*Quercus douglasii*	QUDOU
Valley oak	*Quercus lobata*	QULOB
California bay	*Umbellaria californica*	UMCAL
Shrubs (vines are included in the “shrub” category)		
Coyote brush	*Baccharis pilularis*	BAPIL
Mule fat	*Baccharis salicifolia*	BASAL
Virgin’s bower	*Clematis ligusticifolia*	CLLIG
California rose	*Rosa californica*	ROCAL
California blackberry	*Rubus ursinus*	RUURS
Narrow-leaved willow	*Salix exigua*	SAEXI
Blue elderberry	*Sambucus mexicana*	SAMEX
Snowberry	*Symphorocarpus albus* var. *laevigatus*	SYALB
Undetermined (for first 3 years after planting)[a, b]		
Red willow	*Salix laevigata*	SALAE
Arroyo willow	*Salix lasiolepis*	SALAS
Shining willow	*Salix lucida* ssp. *Lasiandra*	SALUC

*Note: Several herbs and grasses were also planted as part of the mitigation plan but will not be monitored. These plants were aster (*Aster chilensis*), marsh baccharis (*Baccharis douglasii*), western goldenrod (*Euthamia occidentalis*), and creeping wild-rye (*Leymus triticoides*).*

[a] The plant form of 3 willow species (red willow, arroyo willow, and shining willow) will be recorded as undetermined for the first 3 years after they are planted because it is not possible to determine the ultimate growth form of these immature specimens. After 3 years, the plant form of each planted red willow, arroyo willow, and shining willow will be recorded as tree or shrub.

[b] Plants with an undetermined growth form (i.e., willow species indicated in footnote a that were planted less than 3 years ago) are grouped with shrubs unless specifically identified (i.e., as tree, shrub, or undetermined).


GUADALUPE RIVER
Steel Rebar Monument RIP-1 N
Steel Rebar Monument RIP-1 E
Steel Rebar Monument RIP-1 W
Steel Rebar Monument RIP-1 S
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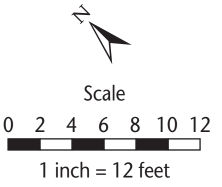
LEGEND
● Present
☒ Missing

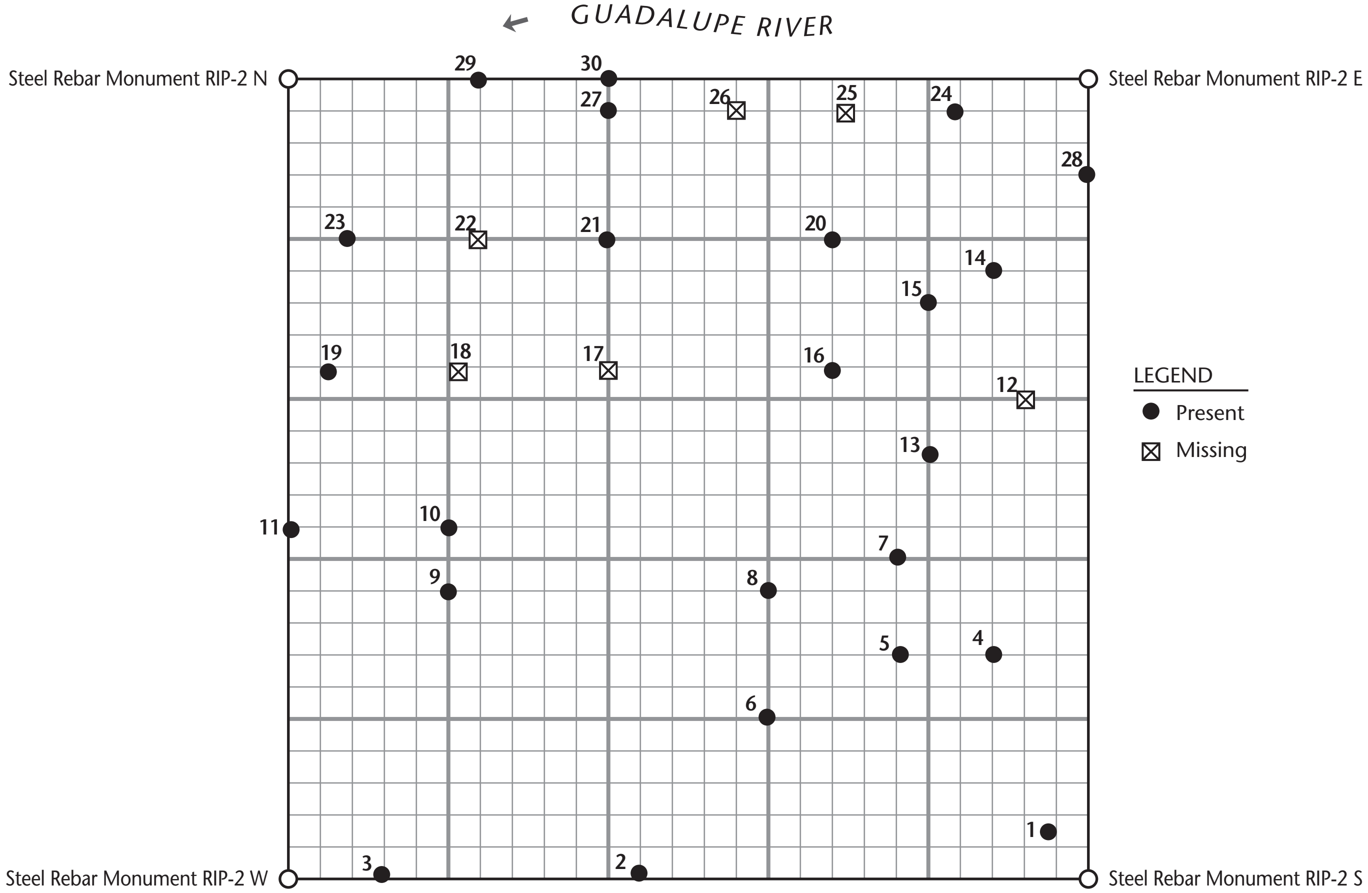
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALAS-01	*Salix lasiolepis*	Arroyo willow
2	SALAE-02	*Salix laevigata*	Red willow
3	SAEXI-03	*Salix exigua*	Narrow-leaved willow
4	SALUC-04	*Salix lucida* ssp. *lasiandra*	Shining willow
5	SALAE-05	*Salix laevigata*	Red willow
6	SALAE-06	*Salix laevigata*	Red willow
7	ACNEG-07	*Acer negundo* var. *californicum*	Box elder
8	SALAS-08	*Salix lasiolepis*	Arroyo willow
9	POBAL-09	*Populus balsamifera* ssp. *trichocarpa*	Black cottonwood *(MISSING)*
10	SALAE-10	*Salix laevigata*	Red willow
11	SAEXI-11	*Salix exigua*	Narrow-leaved willow
12	SALAS-12	*Salix lasiolepis*	Arroyo willow
13	RUURS-13	*Rubus ursinus*	California blackberry
14	SALAE-14	*Salix laevigata*	Red willow
15	RUURS-15	*Rubus ursinus*	California blackberry
16	RUURS-16	*Rubus ursinus*	California blackberry
17	SALAE-17	*Salix laevigata*	Red willow
18	PLRAC-18	*Platanus racemosa*	Western sycamore *(MISSING)*
19	RUURS-19	*Rubus ursinus*	California blackberry
20	ACNEG-20	*Acer negundo* var. *californicum*	Box elder
21	SALAS-21	*Salix lasiolepis*	Arroyo willow *(MISSING)*
22	SALAE-22	*Salix laevigata*	Red willow
23	POFRE-23	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
24	SALAE-24	*Salix laevigata*	Red willow
25	ROCAL-25	*Rosa californica*	California rose
26	RUURS-26	*Rubus ursinus*	California blackberry
27	SALAS-27	*Salix lasiolepis*	Arroyo willow
28	RUURS-28	*Rubus ursinus*	California blackberry
29	SALAE-29	*Salix laevigata*	Red willow
30	ACNEG-30	*Acer negundo* var. *californicum*	Box elder
31	ROCAL-31	*Rosa californica*	California rose
32	POFRE-32	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-1
Riparian Vegetation Sampling Plot RIP-1, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-2 N
Steel Rebar Monument RIP-2 E
Steel Rebar Monument RIP-2 W
Steel Rebar Monument RIP-2 S
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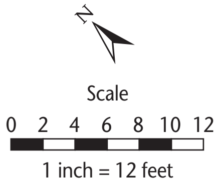
LEGEND
● Present
☒ Missing

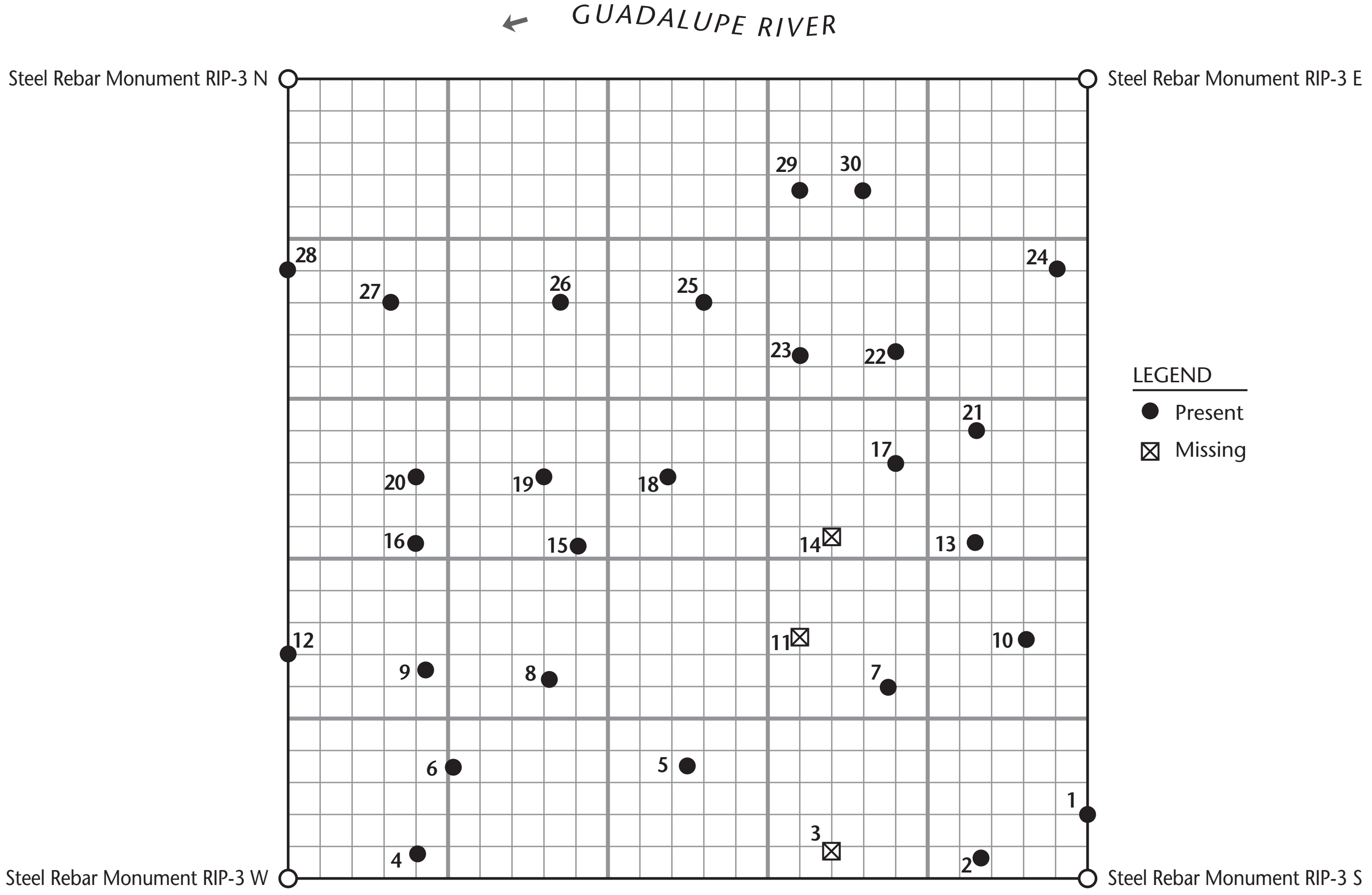
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALAS-01	*Salix lasiolepis*	Arroyo willow
2	POFRE-02	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
3	POFRE-03	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
4	SALAS-04	*Salix lasiolepis*	Arroyo willow
5	SALAS-05	*Salix lasiolepis*	Arroyo willow
6	SALAS-06	*Salix lasiolepis*	Arroyo willow
7	SALAS-07	*Salix laevigata*	Red willow
8	SALAS-08	*Salix lasiolepis*	Arroyo willow
9	SALAS-09	*Salix lasiolepis*	Arroyo willow
10	ACNEG-10	*Acer negundo* var. *californicum*	Box elder
11	SAEXI-11	*Salix exigua*	Narrow-leaved willow
12	PLRAC-12	*Platanus racemosa*	Western sycamore *(MISSING)*
13	SALAE-13	*Salix laevigata*	Red willow
14	SALAS-14	*Salix lasiolepis*	Arroyo willow
15	SALAS-15	*Salix lasiolepis*	Arroyo willow
16	POFRE-16	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
17	POFRE-17	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*
18	POFRE-18	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*
19	RUURS-19	*Rubus ursinus*	California blackberry
20	RUURS-20	*Rubus ursinus*	California blackberry
21	SALAE-21	*Salix laevigata*	Red willow
22	POFRE-22	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*
23	SYALB-23	*Symphoricarpos albus* var. *laevigatus*	Snowberry
24	SALAS-24	*Salix lasiolepis*	Arroyo willow
25	PLRAC-25	*Platanus racemosa*	Western sycamore *(MISSING)*
26	PLRAC-26	*Platanus racemosa*	Western sycamore *(MISSING)*
27	POFRE-27	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
28	QULOB-28	*Quercus lobata*	Valley oak
29	SAEXI-29	*Salix exigua*	Narrow-leaved willow
30	ACNEG-30	*Acer negundo* var. *californicum*	Box elder



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-2
Riparian Vegetation Sampling Plot RIP-2, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-3 N
Steel Rebar Monument RIP-3 E
Steel Rebar Monument RIP-3 W
Steel Rebar Monument RIP-3 S
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14
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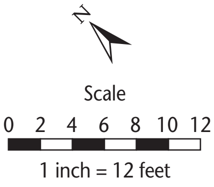
12
10
11
9
8
7
6
5
1
3
4
2
LEGEND
● Present
☒ Missing

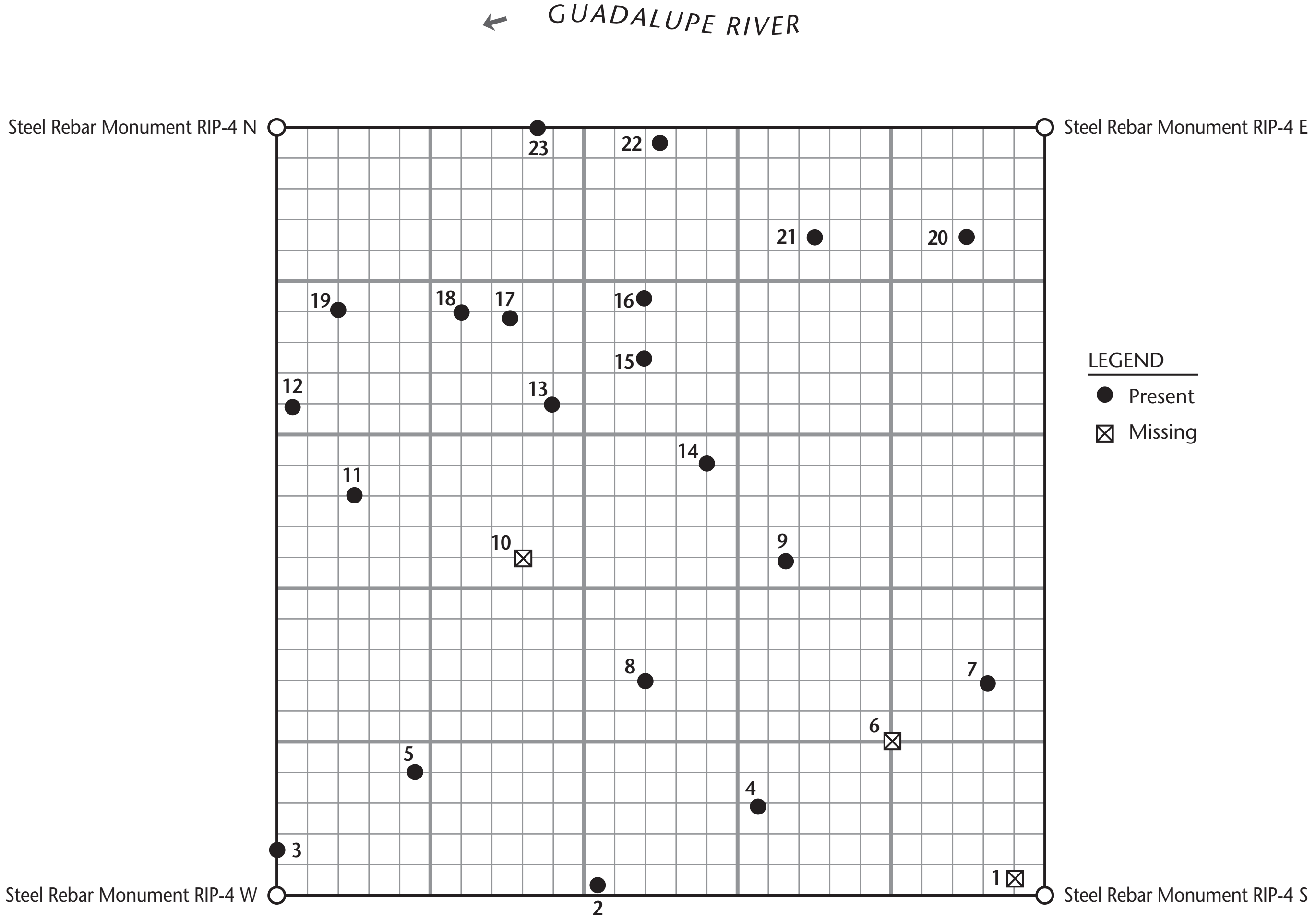
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALAS-01	*Salix lasiolepis*	Arroyo willow
2	SALAS-02	*Salix lasiolepis*	Arroyo willow
3	PLRAC-03	*Platanus racemosa*	Western sycamore *(MISSING)*
4	ACNEG-04	*Acer negundo* var. *californicum*	Box elder
5	ACNEG-05	*Acer negundo* var. *californicum*	Box elder
6	QULOB-06	*Quercus lobata*	Valley oak
7	SAEXI-07	*Salix exigua*	Narrow-leaved willow
8	SALAS-08	*Salix lasiolepis*	Arroyo willow
9	QULOB-09	*Quercus lobata*	Valley oak
10	SALAS-10	*Salix lasiolepis*	Arroyo willow
11	QULOB-11	*Quercus lobata*	Valley oak *(MISSING)*
12	ACNEG-12	*Acer negundo* var. *californicum*	Box elder
13	SALAE-13	*Salix laevigata*	Red willow
14	PLRAC-14	*Platanus racemosa*	Western sycamore *(MISSING)*
15	CLLIG-15	*Clematis ligusticifolia*	Virgin's bower
16	SALAE-16	*Salix laevigata*	Red willow
17	QULOB-17	*Quercus lobata*	Valley oak
18	SALAS-18	*Salix lasiolepis*	Arroyo willow
19	SALUC-19	*Salix lucida* ssp. *lasiandra*	Shining willow
20	SALAE-20	*Salix laevigata*	Red willow
21	SALAS-21	*Salix lasiolepis*	Arroyo willow
22	SALAE-22	*Salix lasiolepis*	Arroyo willow
23	QULOB-23	*Quercus lobata*	Valley oak
24	SALAE-24	*Salix laevigata*	Red willow
25	SALAS-25	*Salix lasiolepis*	Arroyo willow
26	SALAS-26	*Salix lasiolepis*	Arroyo willow
27	SALAS-27	*Salix lasiolepis*	Arroyo willow
28	CLLIG-28	*Clematis ligusticifolia*	Virgin's bower
29	SAEXI-29	*Salix exigua*	Narrow-leaved willow
30	SAEXI-30	*Salix exigua*	Narrow-leaved willow



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-3
Riparian Vegetation Sampling Plot RIP-3, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-4 N
Steel Rebar Monument RIP-4 E
Steel Rebar Monument RIP-4 W
Steel Rebar Monument RIP-4 S
23
22
21
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19
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14
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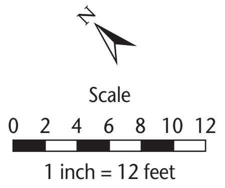
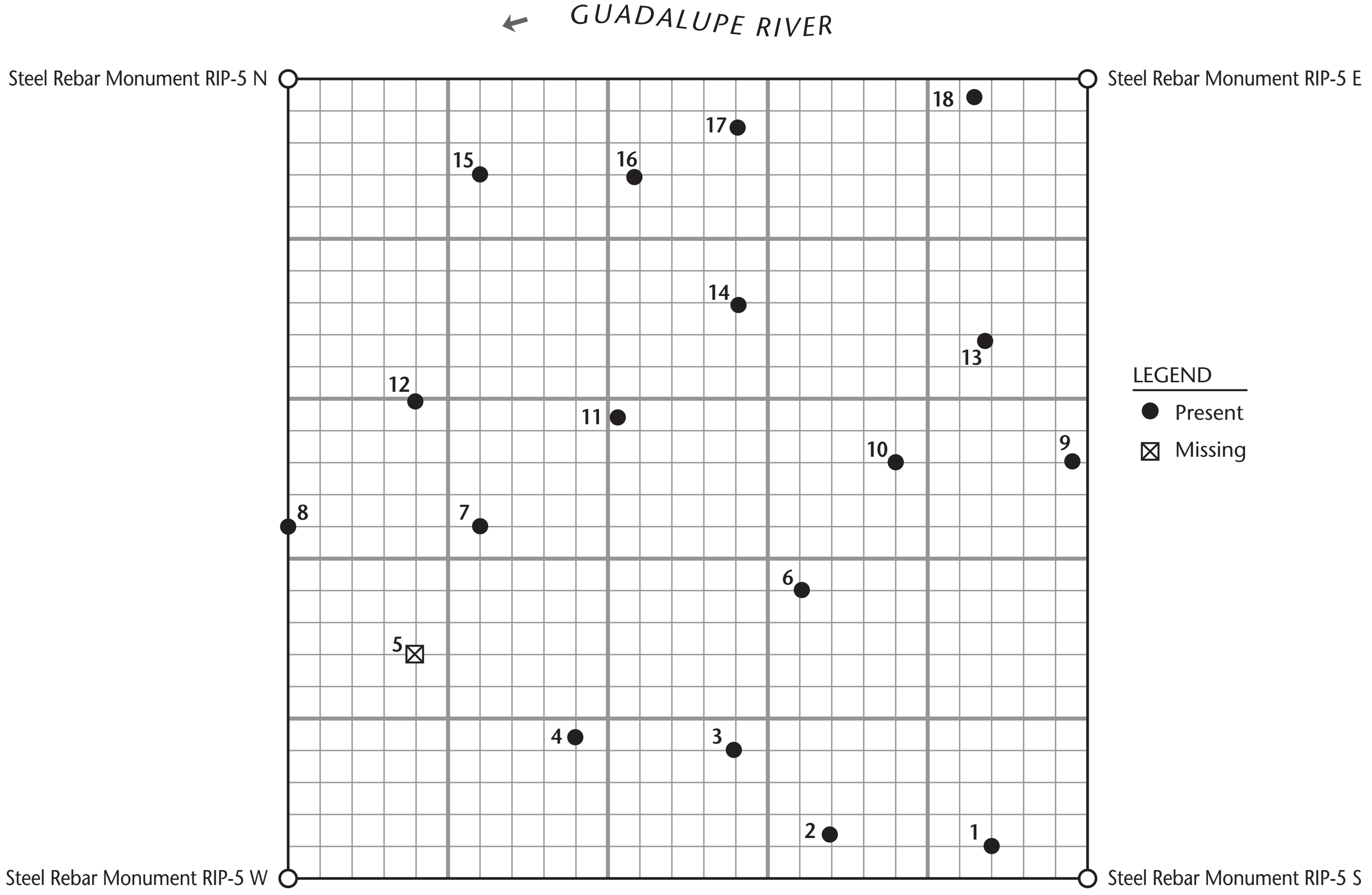
10
9
8
7
6
5
4
3
2
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALAS-01	*Salix lasiolepis*	Arroyo willow *(MISSING)*
2	CLLIG-02	*Clematis ligusticifolia*	Virgin's bower
3	POFRE-03	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
4	BASAL-04	*Baccharis salicifolia*	Mule fat
5	ROCAL-05	*Rosa californica*	California rose
6	POFRE-06	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*
7	POFRE-07	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
8	POFRE-08	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
9	SALAS-09	*Salix lasiolepis*	Arroyo willow
10	SALAS-10	*Salix lasiolepis*	Arroyo willow *(MISSING)*
11	SALAS-11	*Salix lasiolepis*	Arroyo willow
12	SALAS-12	*Salix lasiolepis*	Arroyo willow
13	BASAL-13	*Baccharis salicifolia*	Mule fat
14	ROCAL-14	*Rosa californica*	California rose
15	SALAE-15	*Salix laevigata*	Red willow
16	SALAS-16	*Salix lasiolepis*	Arroyo willow
17	BAPIL-17	*Baccharis pilularis*	Coyote brush
18	POFRE-18	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
19	BASAL-19	*Baccharis salicifolia*	Mule fat
20	SALAE-20	*Salix laevigata*	Red willow
21	POFRE-21	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
22	BASAL-22	*Baccharis salicifolia*	Mule fat
23	SYALB-23	*Symphoricarpos albus* var. *laevigatus*	Snowberry



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

Figure F-4
Riparian Vegetation Sampling Plot RIP-4, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-5 N
Steel Rebar Monument RIP-5 E
Steel Rebar Monument RIP-5 W
Steel Rebar Monument RIP-5 S
18
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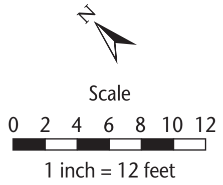
11
10
9
8
7
6
5
4
3
2
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SYALB-01	*Symphoricarpos albus* var. *laevigatus*	Snowberry
2	BASAL-02	*Baccharis salicifolia*	Mule fat
3	SALAS-03	*Salix lasiolepis*	Arroyo willow
4	SYALB-04	*Symphoricarpos albus* var. *laevigatus*	Snowberry
5	SALAS-05	*Salix lasiolepis*	Arroyo willow *(MISSING)*
6	BASAL-06	*Baccharis salicifolia*	Mule fat
7	SALAS-07	*Salix lasiolepis*	Arroyo willow
8	BASAL-08	*Baccharis salicifolia*	Mule fat
9	CLLIG-09	*Clematis ligusticifolia*	Virgin's bower
10	BAPIL-10	*Baccharis pilularis*	Coyote brush
11	POFRE-11	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
12	BAPIL-12	*Baccharis pilularis*	Coyote brush
13	POFRE-13	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
14	BAPIL-14	*Baccharis pilularis*	Coyote brush
15	BASAL-15	*Baccharis salicifolia*	Mule fat
16	QULOB-16	*Quercus lobata*	Valley oak
17	BAPIL-17	*Baccharis pilularis*	Coyote brush
18	QULOB-18	*Quercus lobata*	Valley oak



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

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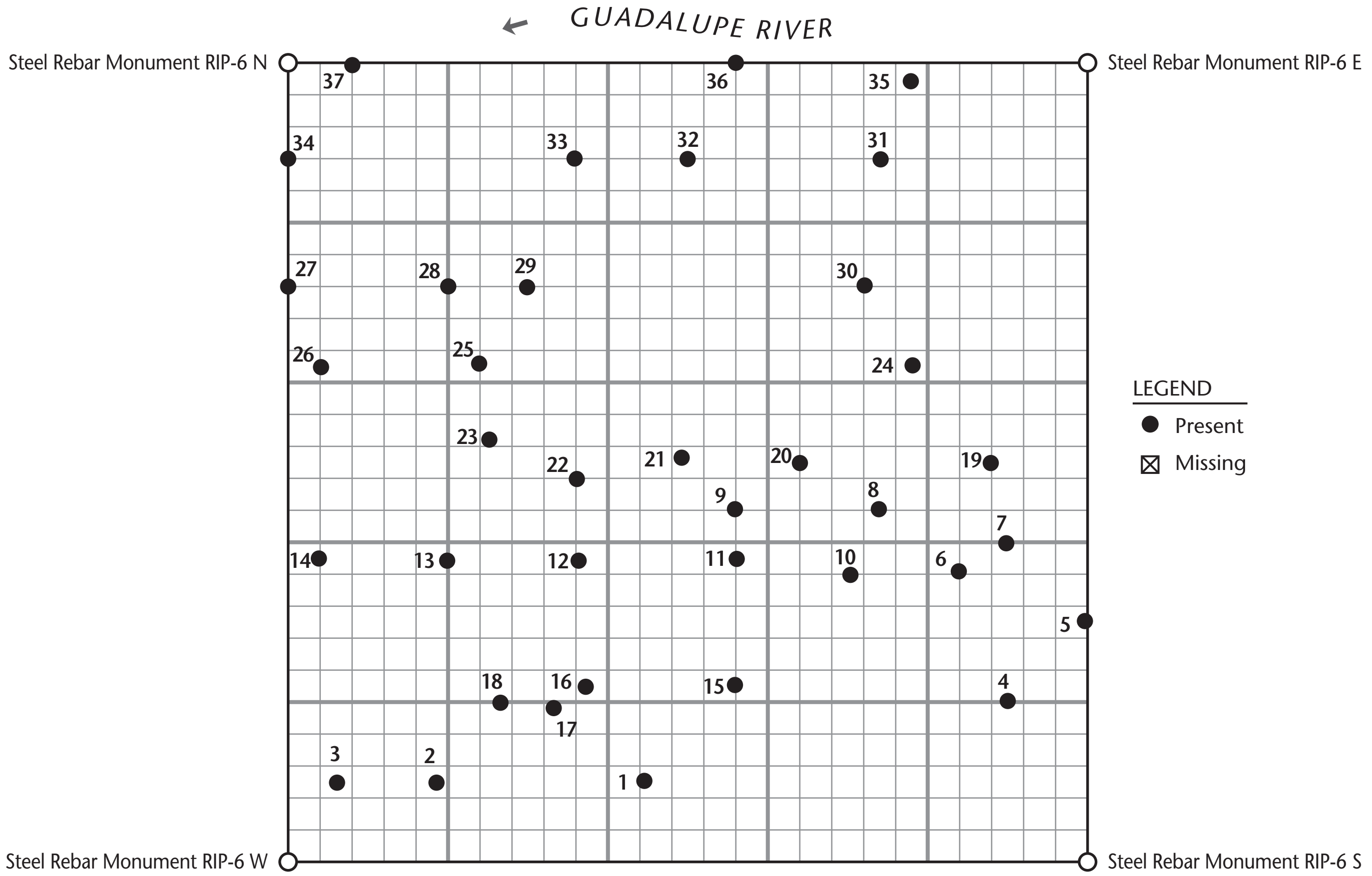
Figure F-5
Riparian Vegetation Sampling Plot RIP-5, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-6 N
Steel Rebar Monument RIP-6 E
Steel Rebar Monument RIP-6 W
Steel Rebar Monument RIP-6 S
37
36
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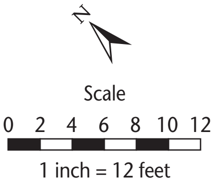
12
11
10
6
5
18
16
15
4
17
3
2
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SAEXI-01	*Salix exigua*	Narrow-leaved willow
2	SAEXI-02	*Salix exigua*	Narrow-leaved willow
3	SAEXI-03	*Salix exigua*	Narrow-leaved willow
4	QULOB-04	*Quercus lobata*	Valley oak
5	POFRE-05	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
6	RUURS-06	*Rubus ursinus*	California blackberry
7	QULOB-07	*Quercus lobata*	Valley oak
8	QULOB-08	*Quercus lobata*	Valley oak
9	RUURS-09	*Rubus ursinus*	California blackberry
10	PLRAC-10	*Platanus racemosa*	Western sycamore *(MISSING)*
11	QULOB-11	*Quercus lobata*	Valley oak
12	RUURS-12	*Rubus ursinus*	California blackberry
13	RUURS-13	*Rubus ursinus*	California blackberry
14	BASAL-14	*Baccharis salicifolia*	Mule fat
15	CLLIG-15	*Clematis ligusticifolia*	Virgin's bower
16	SAEXI-16	*Salix exigua*	Narrow-leaved willow
17	RUURS-17	*Rubus ursinus*	California blackberry
18	RUURS-18	*Rubus ursinus*	California blackberry
19	BAPIL-19	*Baccharis pilularis*	Coyote brush
20	POFRE-20	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
21	RUURS-21	*Rubus ursinus*	California blackberry
22	RUURS-22	*Rubus ursinus*	California blackberry
23	CLLIG-23	*Clematis ligusticifolia*	Virgin's bower
24	SAEXI-24	*Salix exigua*	Narrow-leaved willow
25	SAMEX-25	*Sambucus mexicana*	Blue elderberry
26	SALAS-26	*Salix lasiolepis*	Arroyo willow
27	RUURS-27	*Rubus ursinus*	California blackberry
28	SALAE-28	*Salix laevigata*	Red willow
29	SYALB-29	*Symphoricarpos albus* var. *laevigatus*	Snowberry
30	SAEXI-30	*Salix exigua*	Narrow-leaved willow
31	RUURS-31	*Rubus ursinus*	California blackberry
32	SALAE-32	*Salix laevigata*	Red willow
33	SALAE-33	*Salix laevigata*	Red willow
34	SALUC-34	*Salix lucida* ssp. *lasiandra*	Shining willow
35	ROCAL-35	*Rosa californica*	California rose
36	SALUC-36	*Salix lucida* ssp. *lasiandra*	Shining willow
37	CLLIG-37	*Clematis ligusticifolia*	Virgin's bower



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

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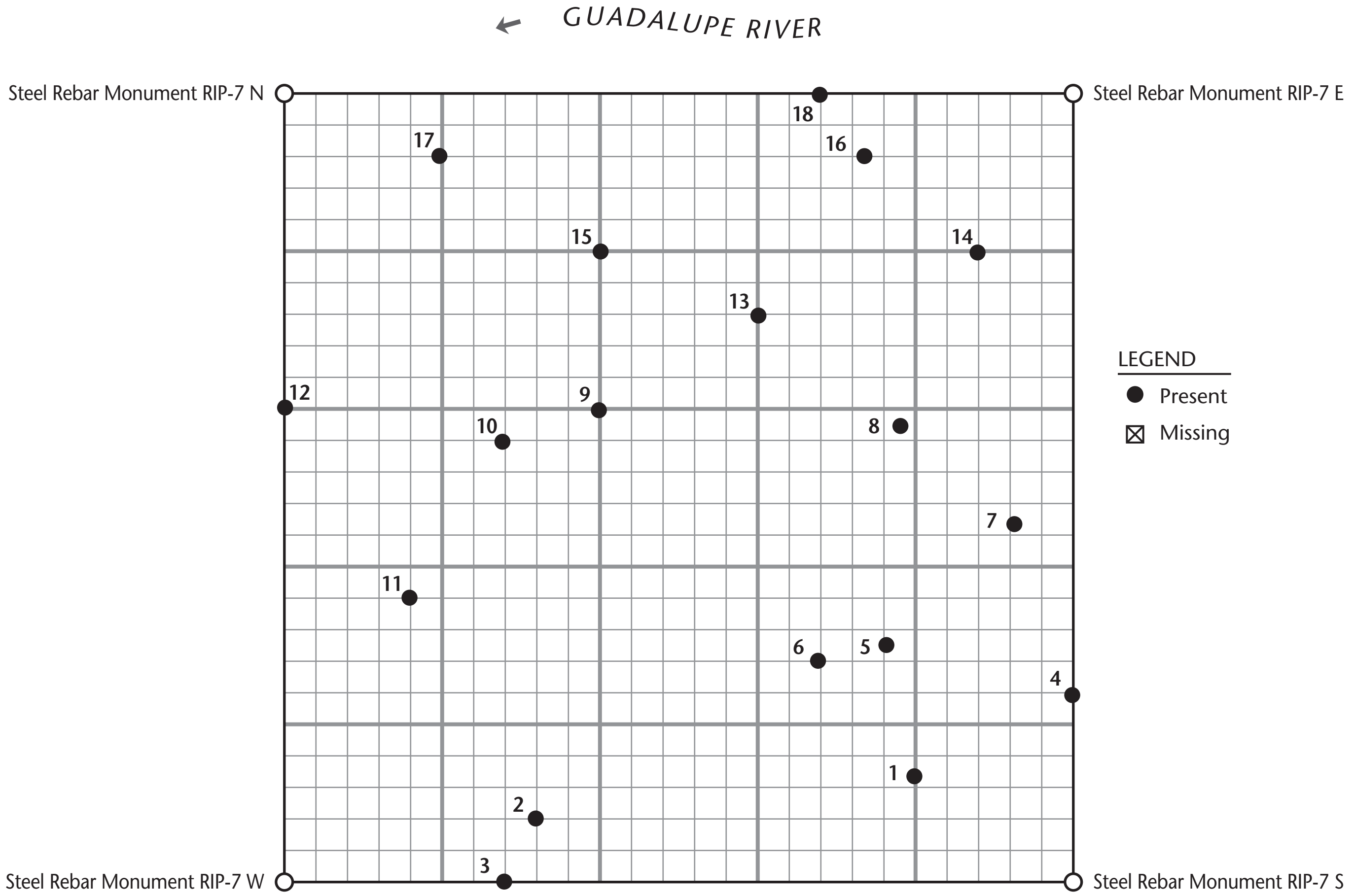
Figure F-6
Riparian Vegetation Sampling Plot RIP-6, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-7 N
Steel Rebar Monument RIP-7 E
Steel Rebar Monument RIP-7 W
Steel Rebar Monument RIP-7 S
18
17
16
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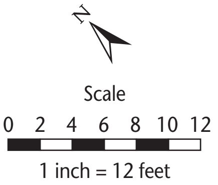
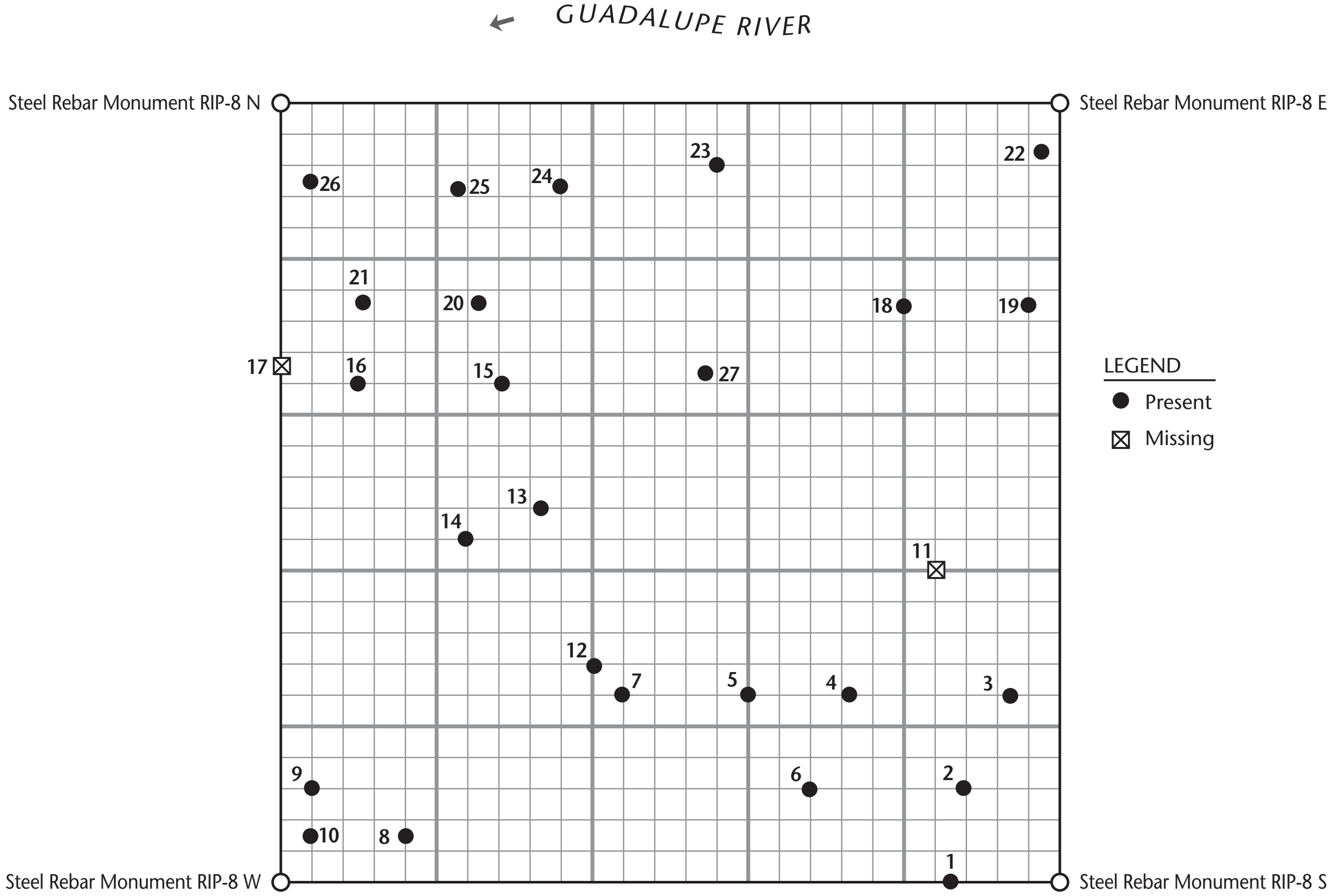
14
13
12
9
10
8
7
11
6
5
4
1
2
3
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SAMEX-01	*Sambucus mexicana*	Blue elderberry
2	POBAL-02	*Populus balsamifera* ssp. *trichocarpa*	Black cottonwood *(MISSING)*
3	SYALB-03	*Symphoricarpos albus* var. *laevigatus*	Snowberry
4	SALAE-04	*Salix laevigata*	Red willow
5	QULOB-05	*Quercus lobata*	Valley oak
6	PLRAC-06	*Platanus racemosa*	Western sycamore *(MISSING)*
7	SAMEX-07	*Sambucus mexicana*	Blue elderberry
8	SAEXI-08	*Salix exigua*	Narrow-leaved willow
9	POFRE-09	*Populus fremontii*	Fremont cottonwood
10	QULOB-10	*Quercus lobata*	Valley oak
11	SYALB-11	*Symphoricarpos albus* var. *laevigatus*	Snowberry
12	SYALB-12	*Symphoricarpos albus* var. *laevigatus*	Snowberry
13	QULOB-13	*Quercus lobata*	Valley oak
14	BASAL-14	*Baccharis salicifolia*	Mule fat
15	SAMEX-15	*Sambucus mexicana*	Blue elderberry
16	SALAS-16	*Salix lasiolepis*	Arroyo willow
17	SALUC-17	*Salix lucida* ssp. *lasiandra*	Shining willow
18	QULOB-18	*Quercus lobata*	Valley oak



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

Figure F-7
Riparian Vegetation Sampling Plot RIP-7, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-8 N
Steel Rebar Monument RIP-8 E
Steel Rebar Monument RIP-8 W
Steel Rebar Monument RIP-8 S
26
25
24
23
22
21
20
18
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17
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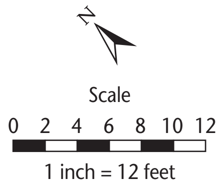
27
13
14
11
12
7
5
4
3
9
6
2
10
8
1
LEGEND
● Present
☒ Missing

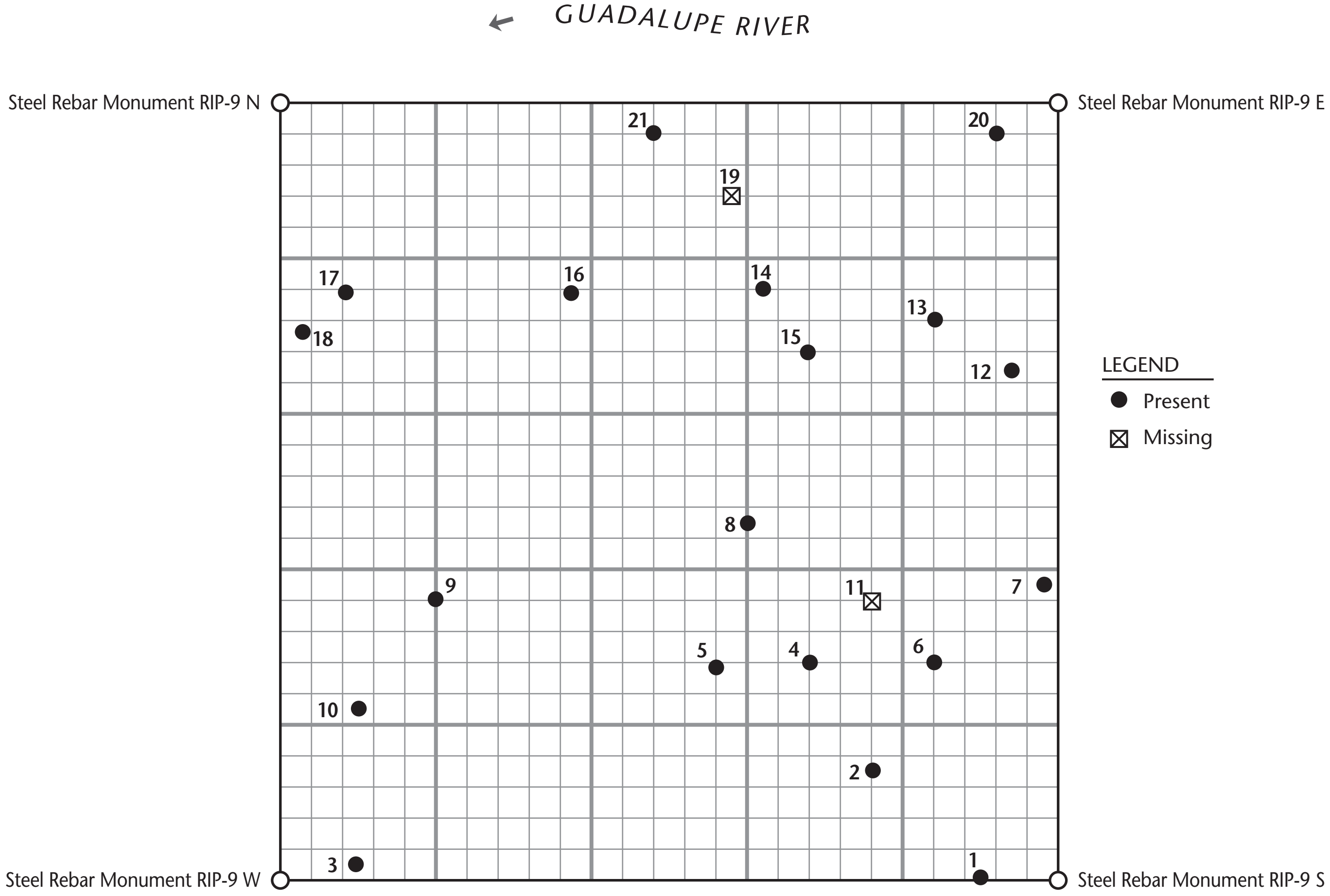
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	QULOB-01	*Quercus lobata*	Valley oak
2	SAMEX-02	*Sambucus mexicana*	Blue elderberry
3	RUURS-03	*Rubus ursinus*	California blackberry
4	SAMEX-04	*Sambucus mexicana*	Blue elderberry
5	SALUC-05	*Salix lucida* ssp. *lasiandra*	Shining willow
6	SAEXI-06	*Salix exigua*	Narrow-leaved willow
7	SAMEX-07	*Sambucus mexicana*	Blue elderberry
8	SAEXI-08	*Salix exigua*	Narrow-leaved willow
9	SAEXI-09	*Salix exigua*	Narrow-leaved willow
10	SAMEX-10	*Sambucus mexicana*	Blue elderberry
11	POFRE-11	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood *(MISSING)*
12	BASAL-12	*Baccharis salicifolia*	Mule fat
13	SYALB-13	*Symphoricarpos albus* var. *laevigatus*	Snowberry
14	BASAL-14	*Baccharis salicifolia*	Mule fat
15	CLLIG-15	*Clematis ligusticifolia*	Virgin's bower
16	SAMEX-16	*Sambucus mexicana*	Blue elderberry
17	PLRAC-17	*Platanus racemosa*	Western sycamore *(MISSING)*
18	SALAS-18	*Salix lasiolepis*	Arroyo willow
19	SAMEX-19	*Sambucus mexicana*	Blue elderberry
20	SAMEX-20	*Sambucus mexicana*	Blue elderberry
21	SALAS-21	*Salix lasiolepis*	Arroyo willow
22	SAEXI-22	*Salix exigua*	Narrow-leaved willow
23	SAEXI-23	*Salix exigua*	Narrow-leaved willow
24	BAPIL-24	*Baccharis pilularis*	Coyote brush
25	SAMEX-25	*Sambucus mexicana*	Blue elderberry
26	SAEXI-26	*Salix exigua*	Narrow-leaved willow
27	SAMEX-27	*Sambucus mexicana*	Blue elderberry



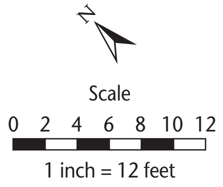
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-8
Riparian Vegetation Sampling Plot RIP-8, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments

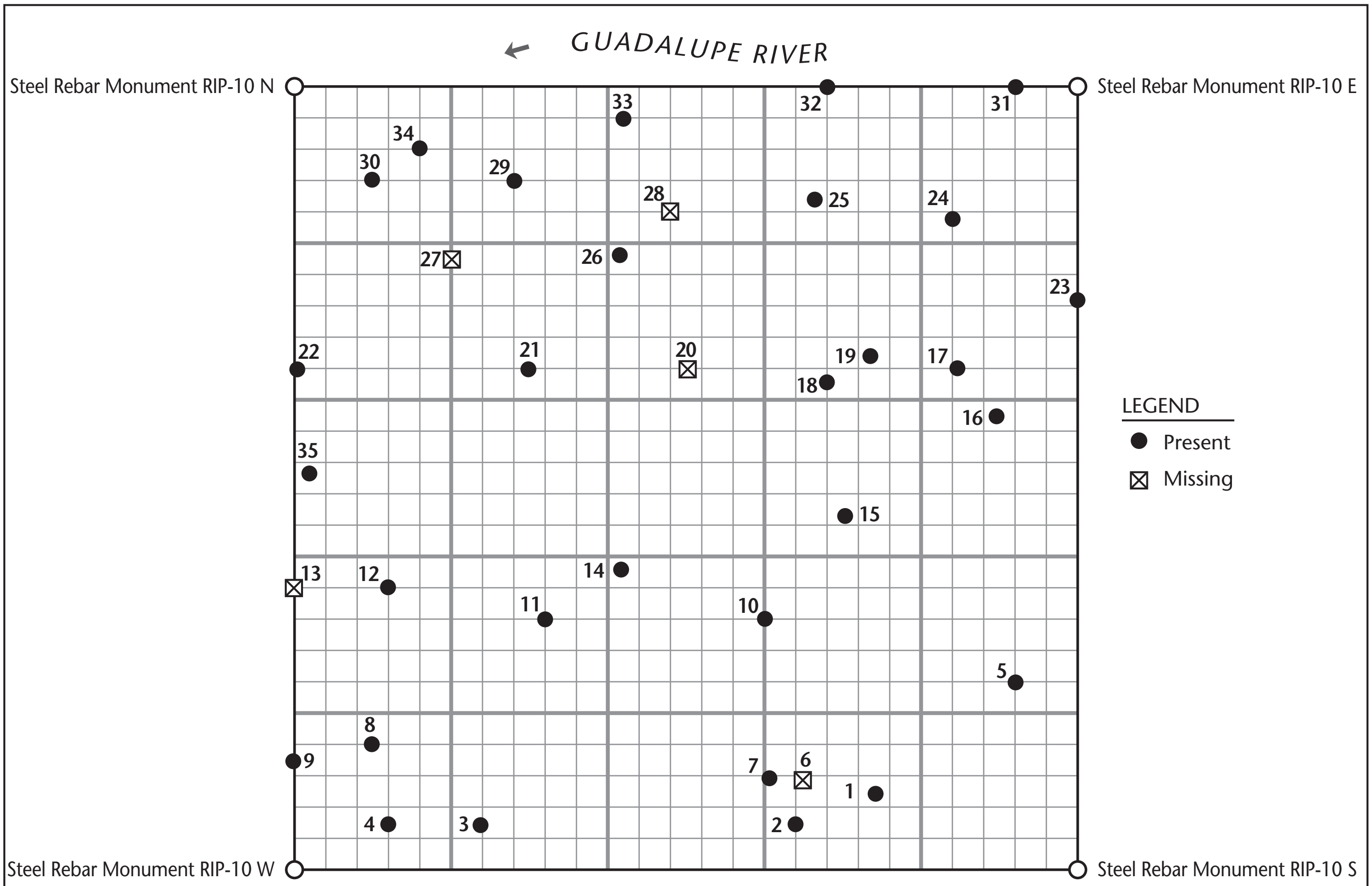

GUADALUPE RIVER
Steel Rebar Monument RIP-9 N
Steel Rebar Monument RIP-9 E
Steel Rebar Monument RIP-9 W
Steel Rebar Monument RIP-9 S
21
20
19
17
16
14
13
18
15
12
8
9
11
7
5
4
6
10
2
3
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SAMEX-01	*Sambucus mexicana*	Blue elderberry
2	POFRE-02	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
3	SAEXI-03	*Salix exigua*	Narrow-leaved willow
4	QULOB-04	*Quercus lobata*	Valley oak
5	BASAL-05	*Baccharis salicifolia*	Mule fat
6	SAEXI-06	*Salix exigua*	Narrow-leaved willow
7	SAMEX-07	*Sambucus mexicana*	Blue elderberry
8	SALAS-08	*Salix lasiolepis*	Arroyo willow
9	BASAL-09	*Baccharis salicifolia*	Mule fat
10	SYALB-10	*Symphoricarpos albus* var. *laevigatus*	Snowberry
11	SAMEX-11	*Sambucus mexicana*	Blue elderberry *(MISSING)*
12	SAMEX-12	*Sambucus mexicana*	Blue elderberry
13	BASAL-13	*Baccharis salicifolia*	Mule fat
14	QULOB-14	*Quercus lobata*	Valley oak
15	SAEXI-15	*Salix exigua*	Narrow-leaved willow
16	BAPIL-16	*Baccharis pilularis*	Coyote brush
17	POFRE-17	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
18	SALAS-18	*Salix lasiolepis*	Arroyo willow
19	PLRAC-19	*Platanus racemosa*	Western sycamore *(MISSING)*
20	SALAE-20	*Salix laevigata*	Red willow
21	SYALB-21	*Symphoricarpos albus* var. *laevigatus*	Snowberry

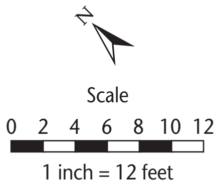


NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

Figure F-9
Riparian Vegetation Sampling Plot RIP-9, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-10 N
Steel Rebar Monument RIP-10 E
Steel Rebar Monument RIP-10 W
Steel Rebar Monument RIP-10 S
33
32
31
34
30
29
28
25
24
27
26
23
22
21
20
19
17
18
16
35
15
13
12
14
11
10
5
8
9
7
6
1
4
3
2
LEGEND
● Present
☒ Missing

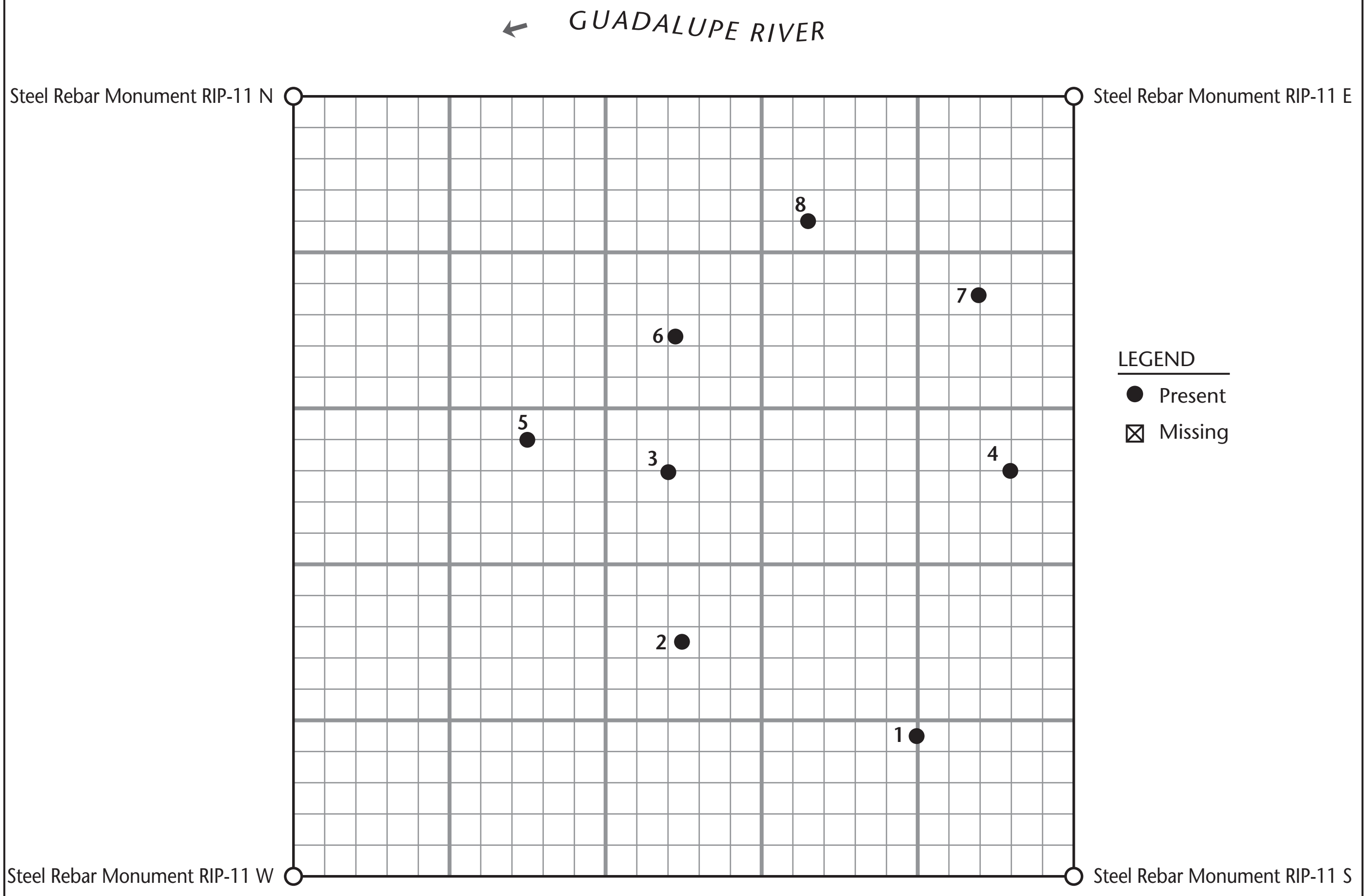
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALUC-01	*Salix lucida ssp. lasiandra*	Shining willow
2	SALAE-02	*Salix laevigata*	Red willow
3	SALAS-03	*Salix lasiolepis*	Arroyo willow
4	SALAS-04	*Salix lasiolepis*	Arroyo willow
5	SALAS-05	*Salix lasiolepis*	Arroyo willow
6	PLRAC-06	*Platanus racemosa*	Western sycamore *(MISSING)*
7	SALAE-07	*Salix laevigata*	Red willow
8	SALAE-08	*Salix laevigata*	Red willow
9	BASAL-09	*Baccharis salicifolia*	Mule fat
10	SALAS-10	*Salix lasiolepis*	Arroyo willow
11	SALAS-11	*Salix lasiolepis*	Arroyo willow
12	SALAE-12	*Salix laevigata*	Red willow
13	PLRAC-13	*Platanus racemosa*	Western sycamore *(MISSING)*
14	CLLIG-14	*Clematis ligusticifolia*	Virgin's bower
15	SALAE-15	*Salix laevigata*	Red willow
16	QULOB-16	*Quercus lobata*	Valley oak
17	CLLIG-17	*Clematis ligusticifolia*	Virgin's bower
18	ACNEG-18	*Acer negundo var. californicum*	Box elder
19	SALAE-19	*Salix laevigata*	Red willow
20	SALUC-20	*Salix lucida ssp. lasiandra*	Shining willow *(MISSING)*
21	SALAE-21	*Salix laevigata*	Red willow
22	SALAE-22	*Salix laevigata*	Red willow
23	SALAS-23	*Salix lasiolepis*	Arroyo willow
24	SALAE-24	*Salix laevigata*	Red willow
25	POBAL-25	*Populus balsamifera ssp. trichocarpa*	Black cottonwood
26	SALAS-26	*Salix lasiolepis*	Arroyo willow
27	SALUC-27	*Salix lucida ssp. lasiandra*	Shining willow *(MISSING)*
28	SALUC-28	*Salix lucida ssp. lasiandra*	Shining willow *(MISSING)*
29	SALUC-29	*Salix lucida ssp. lasiandra*	Shining willow
30	SALAE-30	*Salix laevigata*	Red willow
31	SALAE-31	*Salix laevigata*	Red willow
32	SALAE-32	*Salix laevigata*	Red willow
33	SALAE-33	*Salix laevigata*	Red willow
34	SALAE-34	*Salix laevigata*	Red willow
35	QULOB-35	*Quercus lobata*	Valley oak



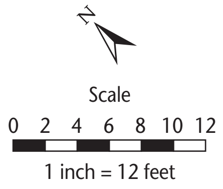
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-10
Riparian Vegetation Sampling Plot RIP-10, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-11 N
Steel Rebar Monument RIP-11 E
Steel Rebar Monument RIP-11 W
Steel Rebar Monument RIP-11 S
8
7
6
5
3
4
2
1
LEGEND
● Present
☒ Missing

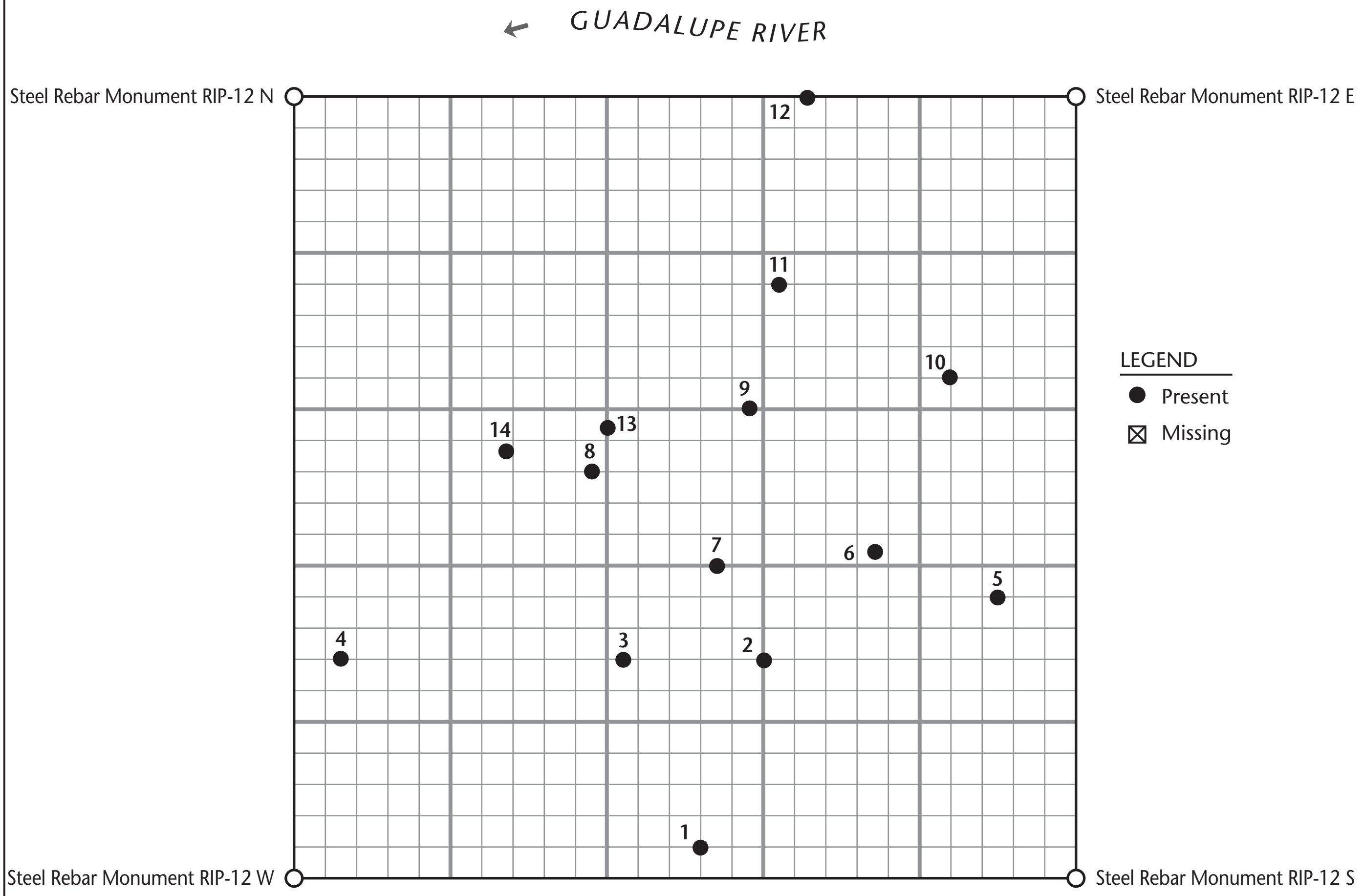
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SAEXI-01	*Salix exigua*	Narrow-leaved willow
2	BASAL-02	*Baccharis salicifolia*	Mule fat
3	SAEXI-03	*Salix exigua*	Narrow-leaved willow
4	POFRE-04	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
5	POFRE-05	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
6	SALAS-06	*Salix lasiolepis*	Arroyo willow
7	SALAE-07	*Salix laevigata*	Red willow
8	POFRE-08	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-11
Riparian Vegetation Sampling Plot RIP-11, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments

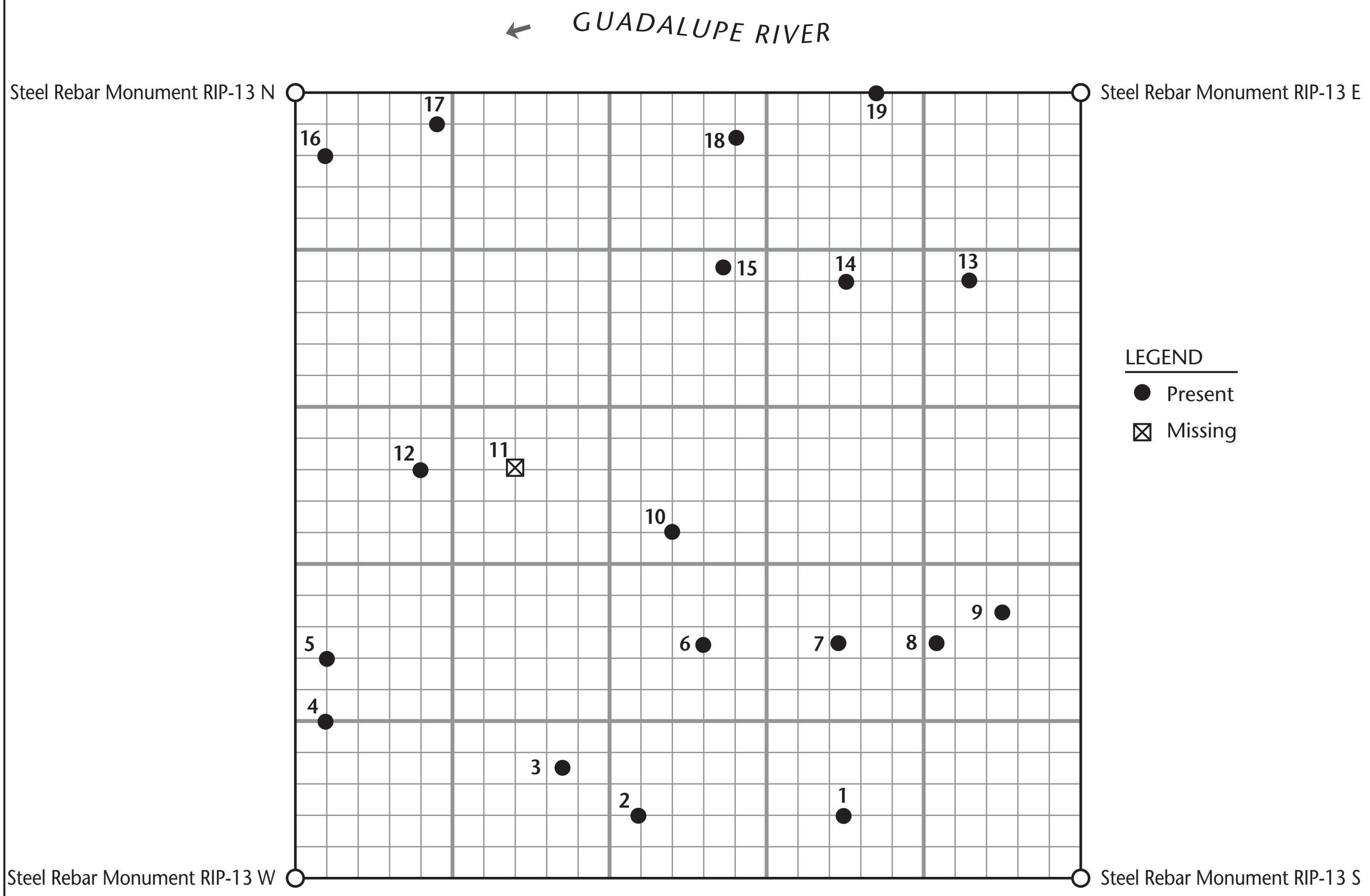

GUADALUPE RIVER
Steel Rebar Monument RIP-12 N
Steel Rebar Monument RIP-12 E
Steel Rebar Monument RIP-12 W
Steel Rebar Monument RIP-12 S
12
11
10
9
13
14
8
7
6
5
4
3
2
1
LEGEND
● Present
☒ Missing
N
Scale
0 2 4 6 8 10 12
1 inch = 12 feet

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	PLRAC-01	*Platanus racemosa*	Western sycamore
2	POFRE-02	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
3	RUURS-03	*Rubus ursinus*	California blackberry
4	POFRE-04	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
5	SYALB-05	*Symphoricarpos albus* var. *laevigatus*	Snowberry
6	ROCAL-06	*Rosa californica*	California rose
7	BAPIL-07	*Baccharis pilularis*	Coyote brush
8	SAMEX-08	*Sambucus mexicana*	Blue elderberry
9	SAMEX-09	*Sambucus mexicana*	Blue elderberry
10	QULOB-10	*Quercus lobata*	Valley oak
11	CLLIG-11	*Clematis ligusticifolia*	Virgin's bower
12	BASAL-12	*Baccharis salicifolia*	Mule fat
13	QULOB-13	*Quercus lobata*	Valley oak
14	QULOB-14	*Quercus lobata*	Valley oak

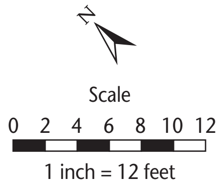
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-12
Riparian Vegetation Sampling Plot RIP-12, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-13 N
Steel Rebar Monument RIP-13 E
Steel Rebar Monument RIP-13 W
Steel Rebar Monument RIP-13 S
17
16
18
19
15
14
13
12
11
10
9
5
6
7
8
4
3
2
1
LEGEND
● Present
☒ Missing

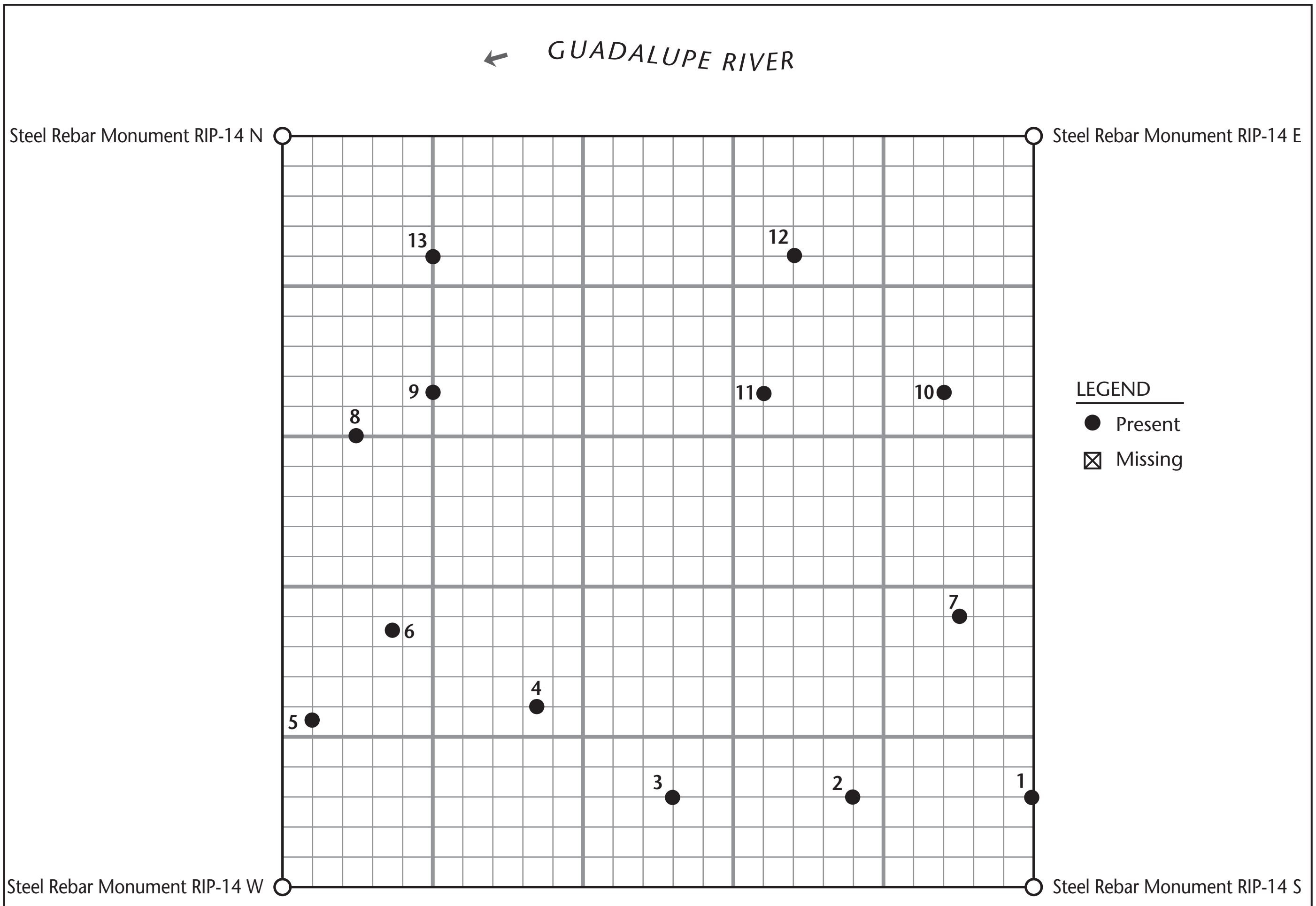
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	RUURS-01	*Rubus ursinus*	California blackberry
2	ROCAL-02	*Rosa californica*	California rose
3	QULOB-03	*Quercus lobata*	Valley oak
4	BASAL-04	*Baccharis salicifolia*	Mule fat
5	POFRE-05	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
6	SALAE-06	*Salix laevigata*	Red willow
7	SYALB-07	*Symphoricarpos albus* var. *laevigatus*	Snowberry
8	RUURS-08	*Rubus ursinus*	California blackberry
9	QULOB-09	*Quercus lobata*	Valley oak
10	POFRE-10	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
11	PLRAC-11	*Platanus racemosa*	Western sycamore *(MISSING)*
12	RUURS-12	*Rubus ursinus*	California blackberry
13	SAMEX-13	*Sambucus mexicana*	Blue elderberry
14	SAMEX-14	*Sambucus mexicana*	Blue elderberry
15	SALUC-15	*Salix lucida* ssp. *lasiandra*	Shining willow
16	SALAS-16	*Salix lasiolepis*	Arroyo willow
17	SAEXI-17	*Salix exigua*	Narrow-leaved willow
18	ROCAL-18	*Rosa californica*	California rose
19	QULOB-19	*Quercus lobata*	Valley oak



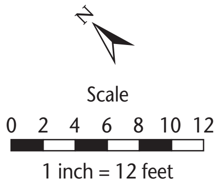
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-13
Riparian Vegetation Sampling Plot RIP-13, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-14 N
Steel Rebar Monument RIP-14 E
Steel Rebar Monument RIP-14 W
Steel Rebar Monument RIP-14 S
13
12
9
11
10
8
7
6
4
5
3
2
1
LEGEND
● Present
☒ Missing

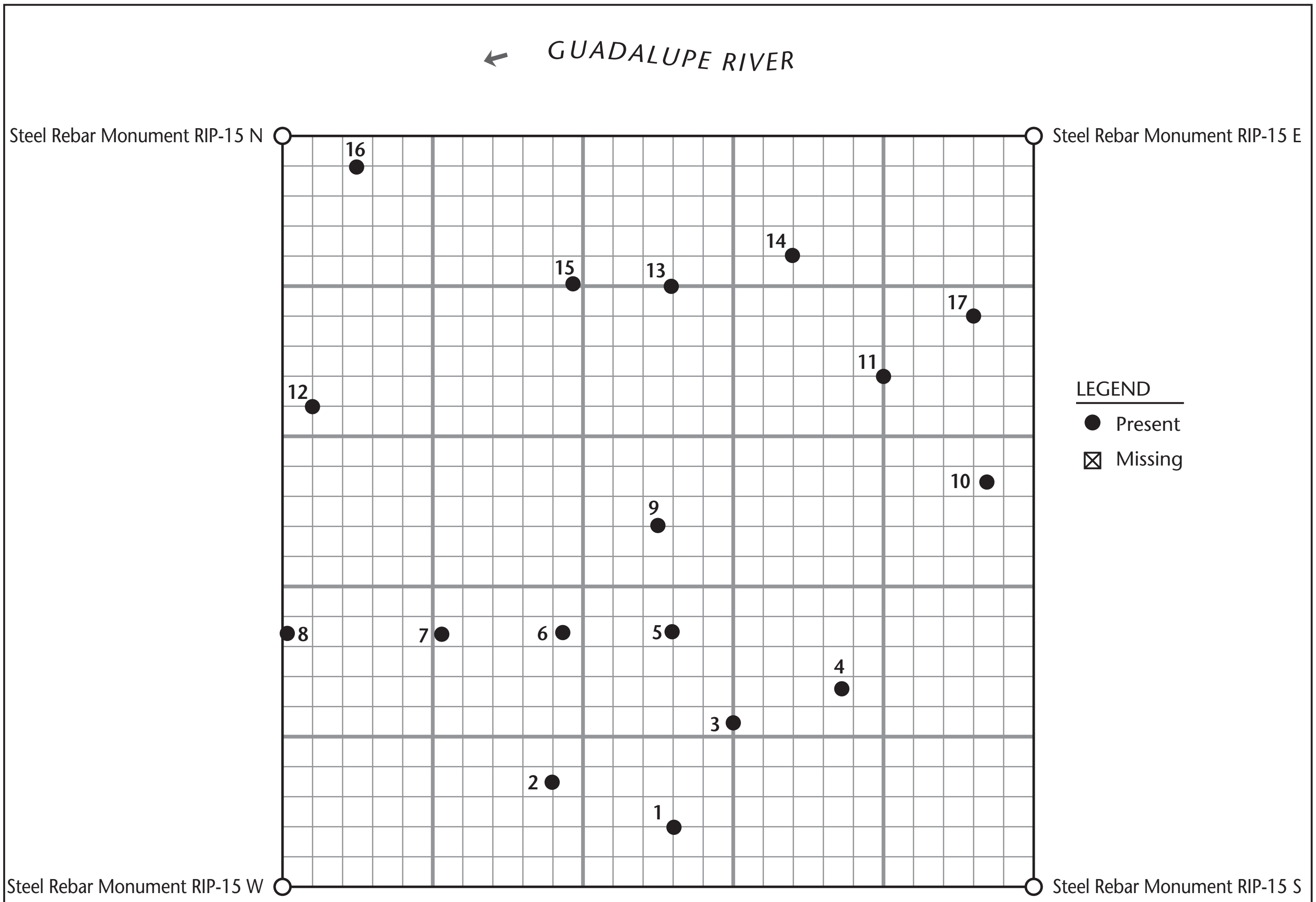
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	SALAS-01	*Salix lasiolepis*	Arroyo willow
2	ROCAL-02	*Rosa californica*	California rose
3	POFRE-03	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
4	QULOB-04	*Quercus lobata*	Valley oak
5	CLLIG-05	*Clematis ligusticifolia*	Virgin's bower
6	CLLIG-06	*Clematis ligusticifolia*	Virgin's bower
7	POFRE-07	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
8	CLLIG-08	*Clematis ligusticifolia*	Virgin's bower
9	SALAE-09	*Salix laevigata*	Red willow
10	ACNEG-10	*Acer negundo* var. *californicum*	Box elder
11	QULOB-11	*Quercus lobata*	Valley oak
12	SALAS-12	*Salix lasiolepis*	Arroyo willow
13	BAPIL-13	*Baccharis pilularis*	Coyote brush



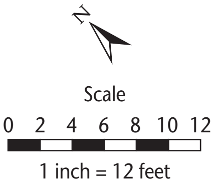
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-14
Riparian Vegetation Sampling Plot RIP-14, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-15 N
Steel Rebar Monument RIP-15 E
Steel Rebar Monument RIP-15 W
Steel Rebar Monument RIP-15 S
16
14
15
13
17
11
12
10
9
8
7
6
5
4
3
2
1
LEGEND
● Present
☒ Missing

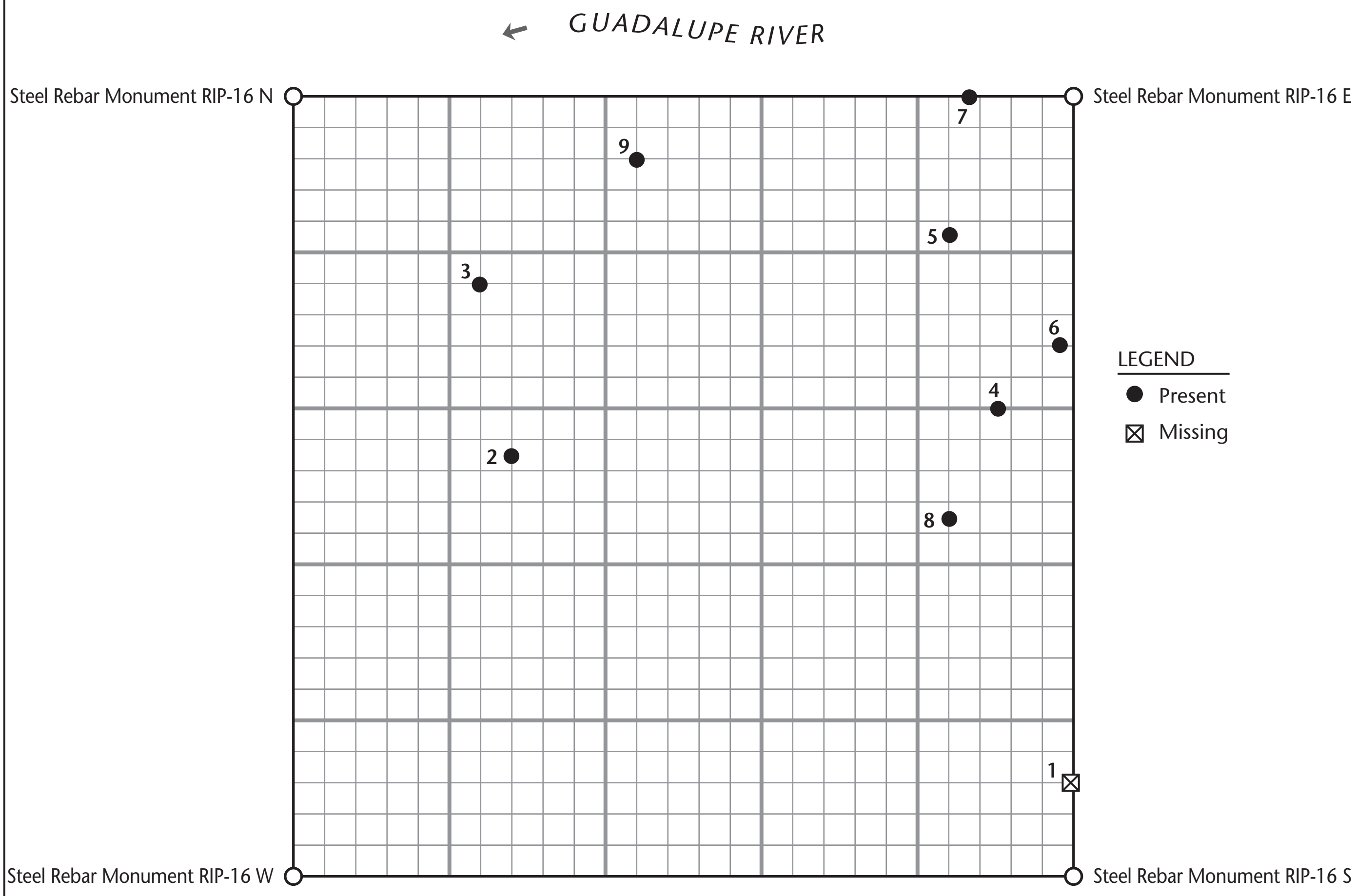
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	QULOB-01	*Quercus lobata*	Valley oak
2	SAEXI-02	*Salix exigua*	Narrow-leaved willow
3	ACNEG-03	*Acer negundo var. californicum*	Box elder
4	ACNEG-04	*Acer negundo var. californicum*	Box elder
5	CLLIG-05	*Clematis ligusticifolia*	Virgin's bower
6	QULOB-06	*Quercus lobata*	Valley oak
7	SALAS-07	*Salix lasiolepis*	Arroyo willow
8	QULOB-08	*Quercus lobata*	Valley oak
9	POFRE-09	*Populus fremontii ssp. fremontii*	Fremont cottonwood
10	SALUC-10	*Salix lucida ssp. lasiandra*	Shining willow
11	ACNEG-11	*Acer negundo var. californicum*	Box elder
12	RUURS-12	*Rubus ursinus*	California blackberry
13	POFRE-13	*Populus fremontii ssp. fremontii*	Fremont cottonwood
14	SAEXI-14	*Salix exigua*	Narrow-leaved willow
15	SAMEX-15	*Sambucus mexicana*	Blue elderberry
16	SALUC-16	*Salix lucida ssp. lasiandra*	Shining willow
17	QULOB-17	*Quercus lobata*	Valley oak



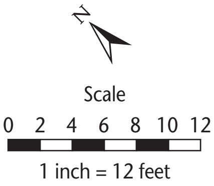
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-15
Riparian Vegetation Sampling Plot RIP-15, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-16 N
Steel Rebar Monument RIP-16 E
Steel Rebar Monument RIP-16 W
Steel Rebar Monument RIP-16 S
7
9
5
3
6
4
2
8
1
LEGEND
● Present
☒ Missing

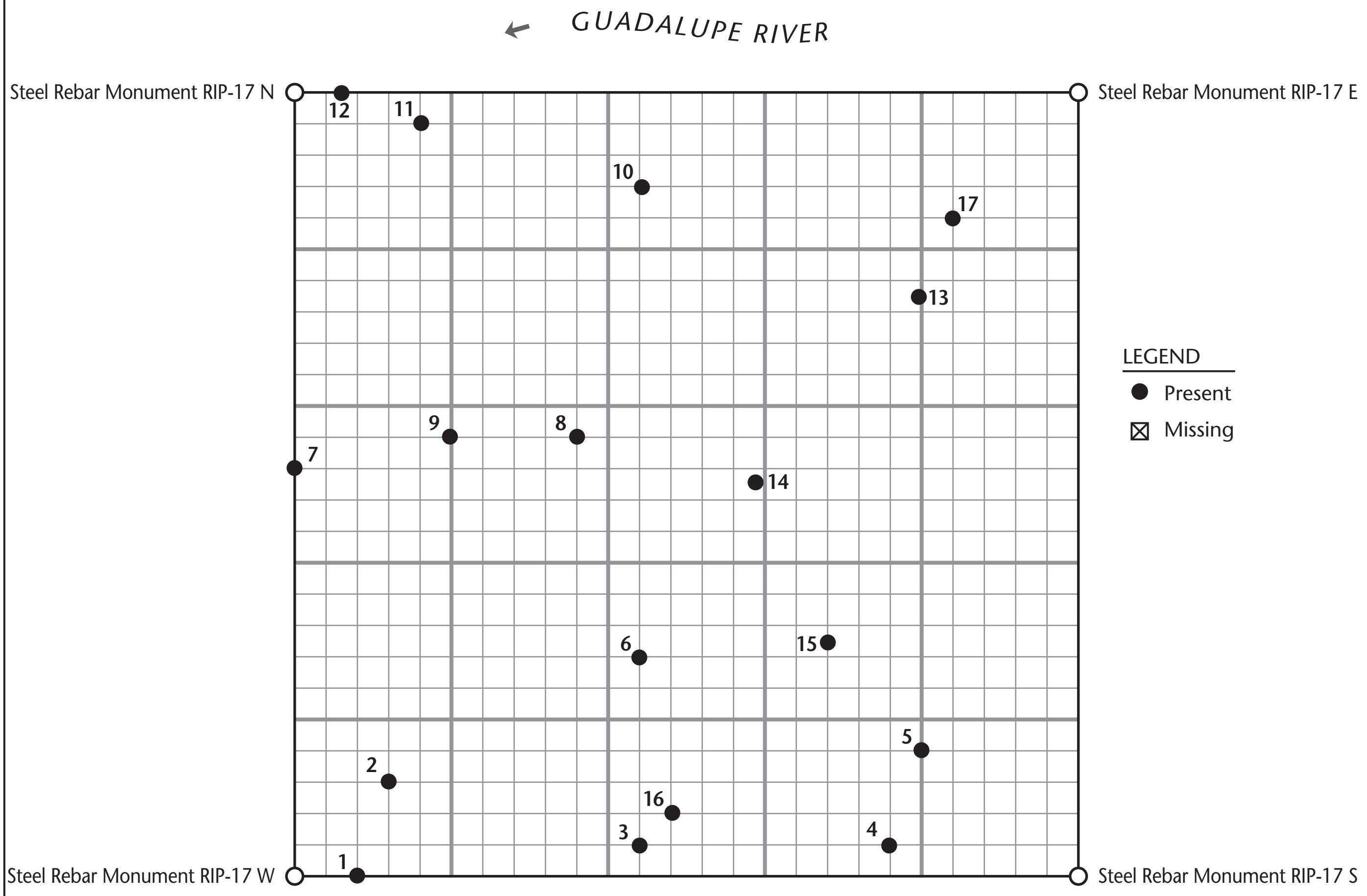
Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	PLRAC-01	*Platanus racemosa*	Western sycamore *(MISSING)*
2	POFRE-02	*Populus fremontii ssp. fremontii*	Fremont cottonwood
3	QULOB-03	*Quercus lobata*	Valley oak
4	SALAS-04	*Salix lasiolepis*	Arroyo willow
5	SAMEX-05	*Sambucus mexicana*	Blue elderberry
6	ACNEG-06	*Acer negundo var. californicum*	Box elder
7	ACNEG-07	*Acer negundo var. californicum*	Box elder
8	SAMEX-08	*Sambucus mexicana*	Blue elderberry
9	ACNEG-09	*Acer negundo var. californicum*	Box elder



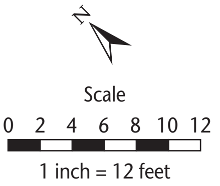
NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-16
Riparian Vegetation Sampling Plot RIP-16, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments

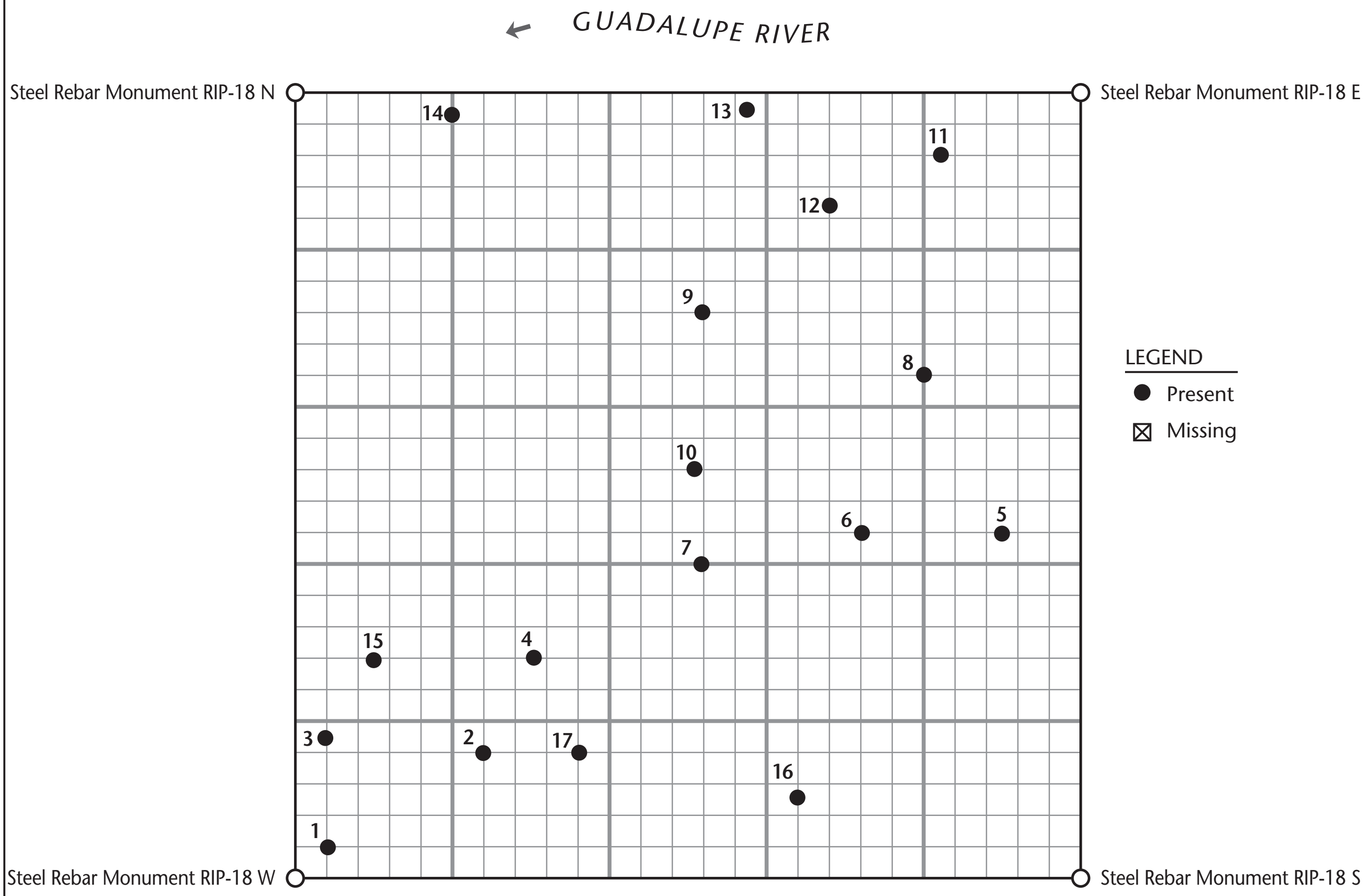

GUADALUPE RIVER
Steel Rebar Monument RIP-17 N
Steel Rebar Monument RIP-17 E
Steel Rebar Monument RIP-17 W
Steel Rebar Monument RIP-17 S
12
11
10
17
13
9
8
7
14
6
15
5
2
16
3
4
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	BAPIL-01	*Baccharis pilularis*	Coyote brush
2	SALAS-02	*Salix lasiolepis*	Arroyo willow
3	SAEXI-03	*Salix exigua*	Narrow-leaved willow
4	SALAE-04	*Salix laevigata*	Red willow
5	SALAS-05	*Salix lasiolepis*	Arroyo willow
6	SALAS-06	*Salix lasiolepis*	Arroyo willow
7	SALAS-07	*Salix lasiolepis*	Arroyo willow
8	SAEXI-08	*Salix exigua*	Narrow-leaved willow
9	POFRE-09	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
10	SAMEX-10	*Sambucus mexicana*	Blue elderberry
11	SAMEX-11	*Sambucus mexicana*	Blue elderberry
12	ACNEG-12	*Acer negundo* var. *californicum*	Box elder
13	RUURS-13	*Rubus ursinus*	California blackberry
14	RUURS-14	*Rubus ursinus*	California blackberry
15	SAMEX-15	*Sambucus mexicana*	Blue elderberry
16	CLLIG-16	*Clematis ligusticifolia*	Virgin's bower
17	SAMEX-17	*Sambucus mexicana*	Blue elderberry

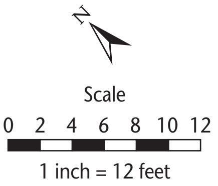


NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

Figure F-17
Riparian Vegetation Sampling Plot RIP-17, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments


GUADALUPE RIVER
Steel Rebar Monument RIP-18 N
Steel Rebar Monument RIP-18 E
Steel Rebar Monument RIP-18 W
Steel Rebar Monument RIP-18 S
14
13
11
12
9
8
10
6
5
7
15
4
3
2
17
16
1
LEGEND
● Present
☒ Missing

Plant Number	Species Code and Plant Number	Scientific Name	Common Name
1	ACNEG-01	*Acer negundo* var. *californicum*	Box elder
2	SALAS-02	*Salix lasiolepis*	Arroyo willow
3	POFRE-03	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
4	BAPIL-04	*Baccharis pilularis*	Coyote brush
5	ACNEG-05	*Acer negundo* var. *californicum*	Box elder
6	SALAS-06	*Salix lasiolepis*	Arroyo willow
7	POFRE-07	*Populus fremontii* ssp. *fremontii*	Fremont cottonwood
8	ACNEG-08	*Acer negundo* var. *californicum*	Box elder
9	SALAS-09	*Salix lasiolepis*	Arroyo willow
10	ACNEG-10	*Acer negundo* var. *californicum*	Box elder
11	ACNEG-11	*Acer negundo* var. *californicum*	Box elder
12	SALAE-12	*Salix laevigata*	Red willow
13	ACNEG-13	*Acer negundo* var. *californicum*	Box elder
14	SALAS-14	*Salix lasiolepis*	Arroyo willow
15	SAMEX-15	*Sambucus mexicana*	Blue elderberry
16	SYALB-16	*Symphoricarpos albus* var. *laevigatus*	Snowberry
17	RUURS-17	*Rubus ursinus*	California blackberry



NOTE: Steel rebar monument is steel cap on rebar stake (at grade) marked with sampling plot number and north (N), south (S), east (E), or west (W) designation (e.g., RIP-1 N).

0F028.00 (IP)

Figure F-18
Riparian Vegetation Sampling Plot RIP-18, Showing Locations of Planted Trees and Shrubs and Steel Rebar Monuments

Appendix G

Benchmarks Used during Channel Bottom Stability Monitoring

Appendix G

Benchmarks Used during Channel Bottom Stability Monitoring

Table G-1. Benchmarks Used during Channel Bottom Stability Monitoring

Benchmark Number	Location	Elevation (feet)
SCVWD benchmark 292	Brass cap on southeast corner of Coleman Avenue Bridge over the Guadalupe River	73.52
City of San Jose reference mark 802	Chiseled square in concrete, northerly edge of monument box in the middle of intersection of St. John. and River Streets	76.80
City of San Jose reference mark 798	Chiseled "L" east top of curb on Locust Street, 113 feet south of Woz Way centerline	88.48

Note: Vertical Datum: NAVD 1929.

Source: Fernando Munoz, land surveyor for SCVWD. Fax to Luke Rutten of Jones & Stokes on January 23, 2002. Mel Sheppard, City of San Jose. Fax to Luke Rutten of Jones & Stokes on July 18, 2001.

Table G-2. Elevations of Known Points for Channel Bottom Stability Cross Sections

Cross Section Identification Number	Known Point	Elevation (feet)
CT-1	Top of west bank permanent monument	63.30
CT-2	Top of east bank permanent monument	61.09
CT-3	Top of west bank permanent monument	61.94
CT-4	Top of west bank permanent monument	62.02
CT-5	Top of west bank permanent monument	61.96
CT-6	Top of east bank permanent monument	77.26
CT-7	Top of east bank permanent monument	71.09
CT-8	Top of east bank permanent monument	65.35
CT-9	Top of east bank permanent monument	78.68
CT-10	Top of east bank permanent monument	77.37
CT-11	Top of east bank permanent monument [a]	84.82
CT-12	Top of east bank permanent monument [a]	90.05
CT-13	Top of west bank permanent monument [a]	84.23

Note: Vertical Datum: NAVD 1929.

[a] A temporary benchmark was used to survey this transect. The elevation of the east bank permanent monument was calculated using the elevation of the temporary benchmark.

Appendix H

Instructions for Using the JSATEMP Stream Temperature Model

Appendix H

Instructions for Using the JSATEMP Stream Temperature Model

H.1 Introduction

This appendix contains instructions on how to use the JSATEMP stream temperature model (JSATEMP model) of the Guadalupe River system. The model is a Lotus 1-2-3, spreadsheet-based stream temperature model that uses hourly meteorological data and daily stream flow data to simulate hourly water temperature.

These instructions are only a general guide to understanding the primary JSATEMP model components, particularly those relevant to the *Implementation Plan for the Guadalupe River Project Mitigation and Monitoring Plan* (IP), a stand-alone document that provides detailed instructions for collecting, managing, and analyzing and evaluating environmental monitoring data for the Guadalupe River Project (Project). To become more familiar with all parts of the model, the user should study the details of the model equations and model organization by reviewing the model spreadsheet.

Typically, the first step in using the JSATEMP model is to put current data (such as data representing current-postproject conditions for the IP) into the model and simulate current water temperatures. These simulated current water temperatures are compared to measured water temperatures to determine whether the model is performing satisfactorily. Once the model is performing satisfactorily, model inputs may be adjusted to simulate other conditions (e.g., no-project conditions for the IP).

This appendix is organized into the following sections

- "Description of the JSATEMP Stream Temperature Model,"
- "Developing JSATEMP Stream Temperature Model Inputs,"
- "Evaluating JSATEMP Stream Temperature Model Components for the Implementation Plan,"
- "Running the JSATEMP Stream Temperature Model,"
- "Evaluating the JSATEMP Stream Temperature Model Performance and Making Adjustments," and
- "Evaluating Project Effects."

Additional description of the model can be found in chapter 6 of the IP and in *Simulation of Temperature Impacts and Associated Mitigation Measures for the Guadalupe River Project, Downtown San Jose, California* (U.S. Army Corps of Engineers, 2004).

Most of this appendix contains general instructions for using the JSATEMP model for any project. However, some sections (especially H.4 and H.7) are tailored to using the model for the IP.

H.2 Description of JSATEMP Stream Temperature Model

The JSATEMP model has 39 segments representing the Guadalupe River system. The model segments cover Arroyo Calero, Alamitos Creek, Guadalupe Creek, and the Guadalupe River (figure 6-4). The length of river represented by individual model segments ranges from 0.2 to 1.5 miles. Each spreadsheet file contains all the data needed to simulate hourly water temperatures for a 1-month period.

The water temperature in each model segment is calculated using 1) the temperature of the water flowing into the segment and 2) multiple heat transfer relationships. These relationships are based on heat transfer equations that account for

- solar radiation,
- stream shading,
- long-wave radiation to and from the water surface,
- evaporation,
- convection, and
- bed conduction.

The model is made up of 7 sheets (i.e., pages), but only a small part of each model sheet can be viewed on the computer screen. Therefore, figures H-1–H-7

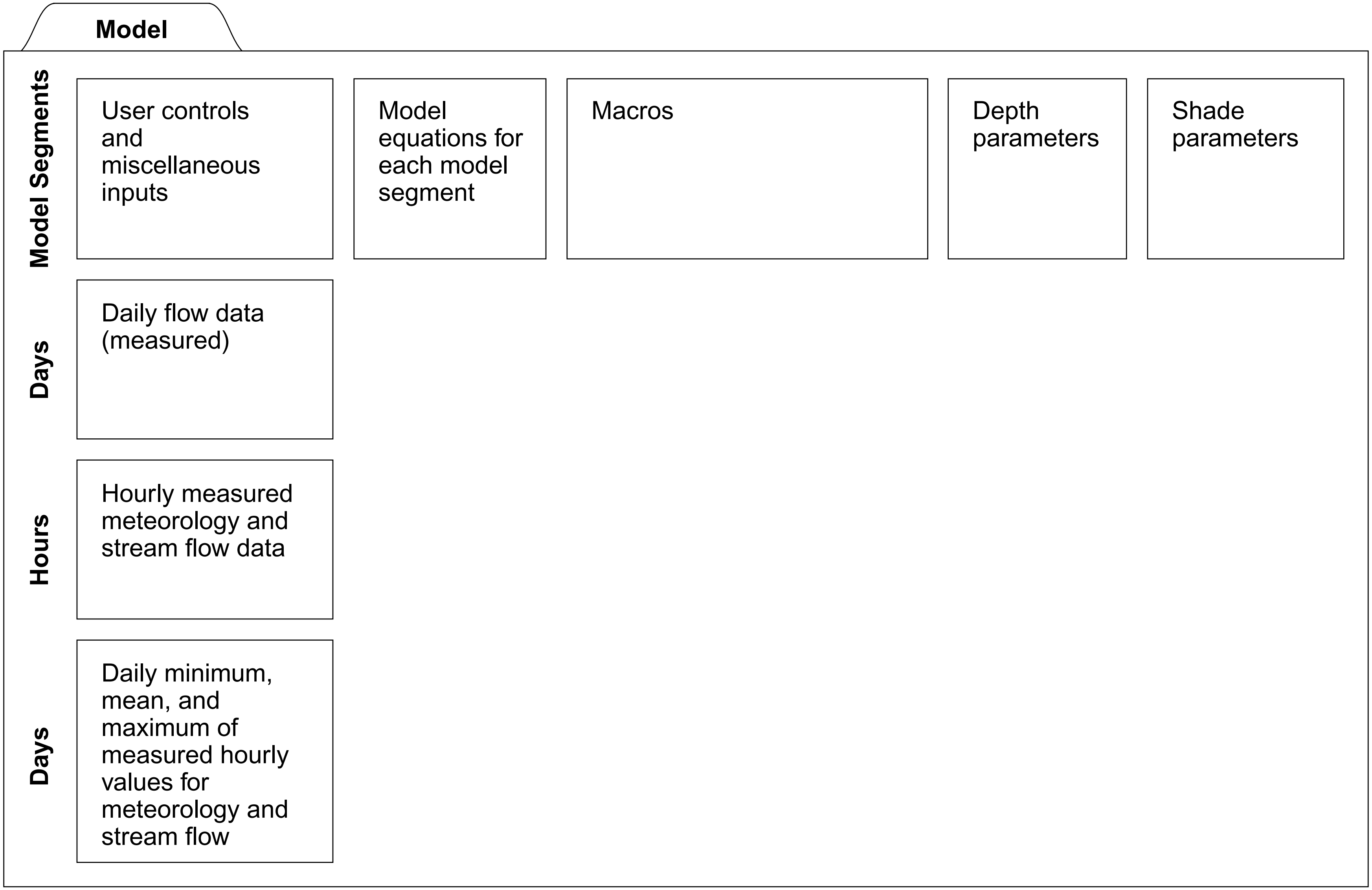

Model
Model Segments
User controls and miscellaneous inputs
Model equations for each model segment
Macros
Depth parameters
Shade parameters
Days
Daily flow data (measured)
Hours
Hourly measured meteorology and stream flow data
Days
Daily minimum, mean, and maximum of measured hourly values for meteorology and stream flow

Figure H-1
Organization of Sheet "Model" in the JSATEMP Stream Temperature Model Spreadsheet

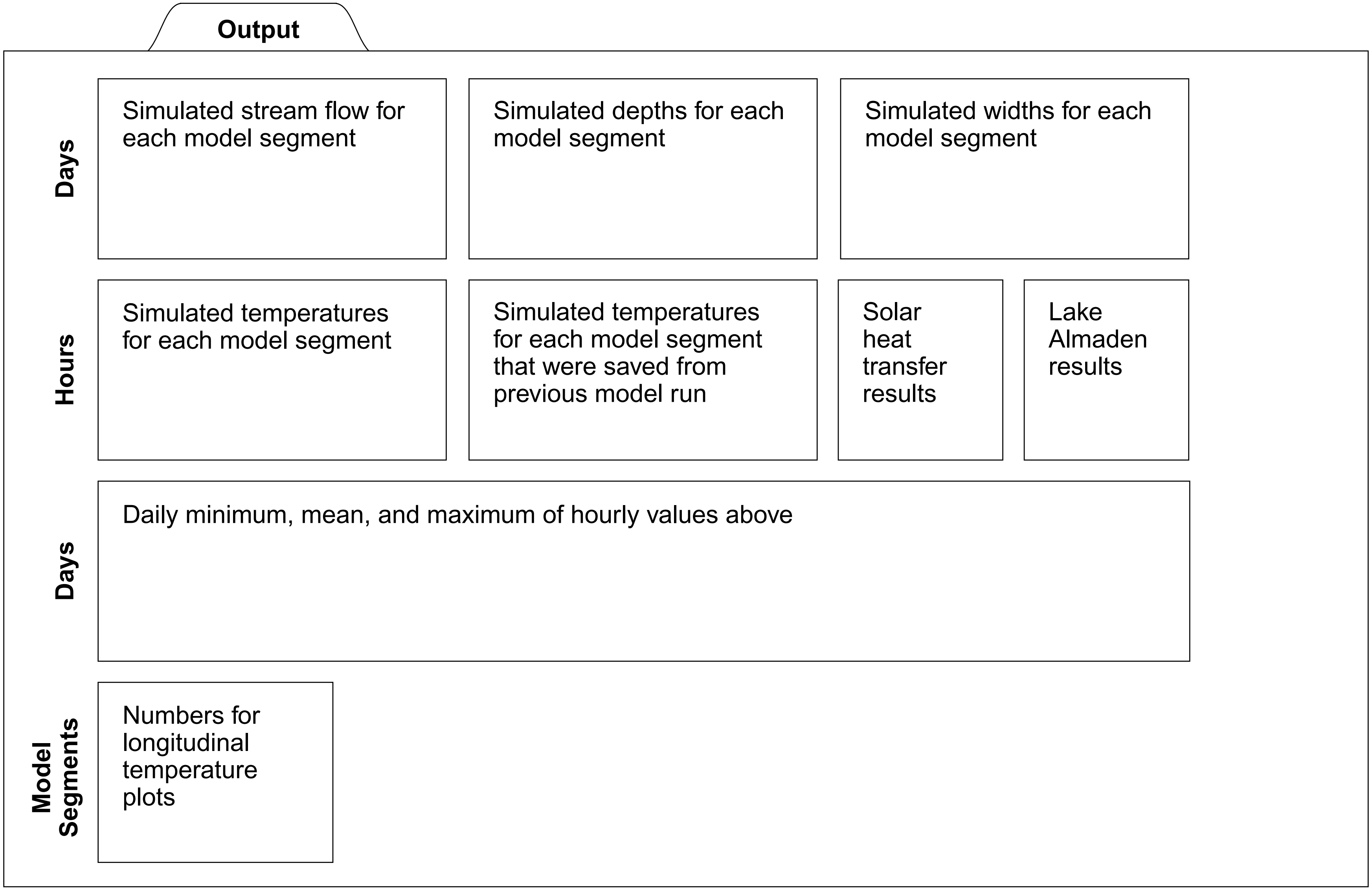

Output
Days
Simulated stream flow for each model segment
Simulated depths for each model segment
Simulated widths for each model segment
Hours
Simulated temperatures for each model segment
Simulated temperatures for each model segment that were saved from previous model run
Solar heat transfer results
Lake Almaden results
Days
Daily minimum, mean, and maximum of hourly values above
Model Segments
Numbers for longitudinal temperature plots

Figure H-2
Organization of Sheet "Output" in the JSATEMP Stream Temperature Model Spreadsheet

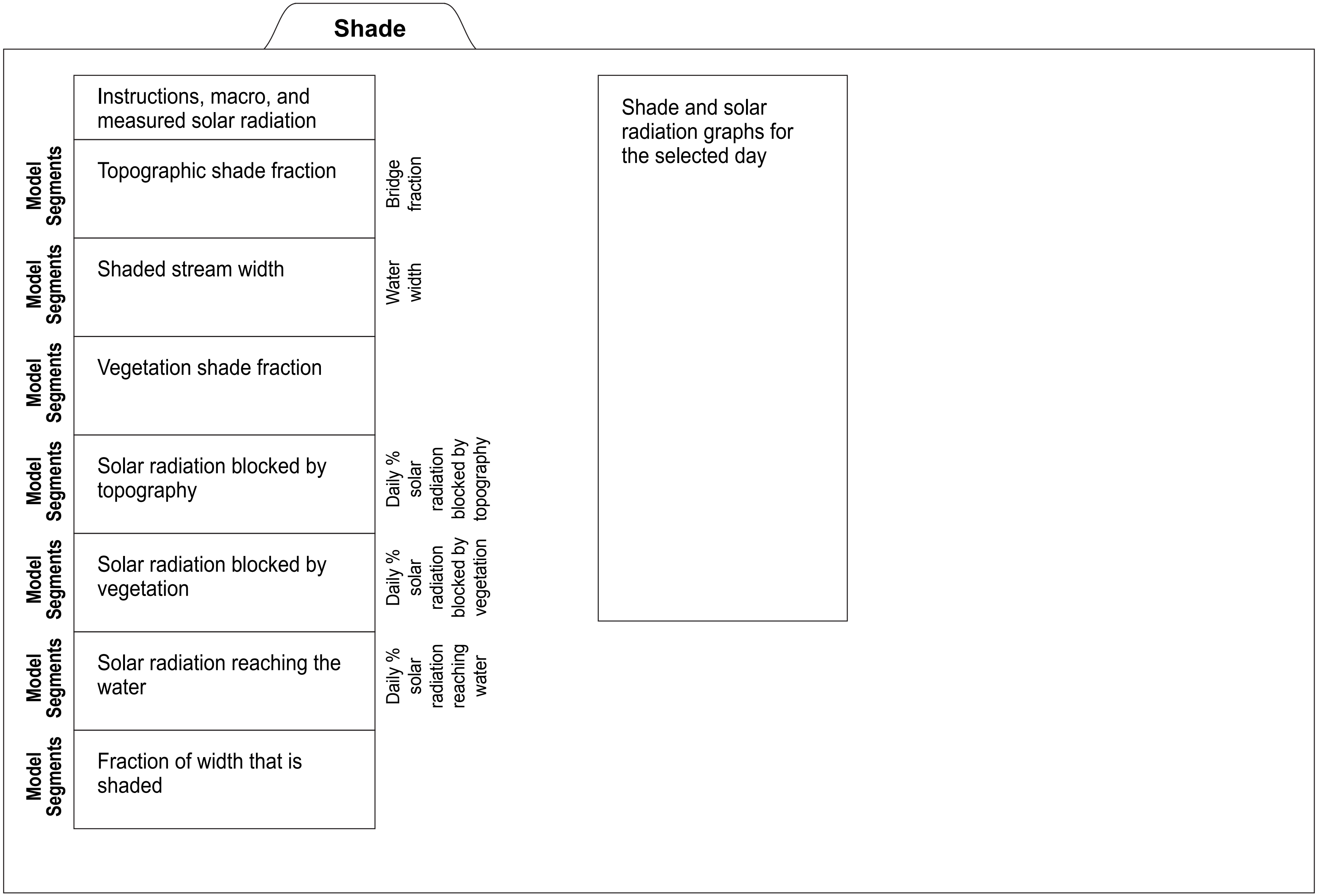

Shade
Instructions, macro, and measured solar radiation
Model Segments
Topographic shade fraction
Bridge fraction
Model Segments
Shaded stream width
Water width
Model Segments
Vegetation shade fraction
Model Segments
Solar radiation blocked by topography
Daily % solar radiation blocked by topography
Model Segments
Solar radiation blocked by vegetation
Daily % solar radiation blocked by vegetation
Model Segments
Solar radiation reaching the water
Daily % solar radiation reaching water
Model Segments
Fraction of width that is shaded
Shade and solar radiation graphs for the selected day

Figure H-3
Organization of Sheet "Shade" in the JSATEMP Stream Temperature Model Spreadsheet

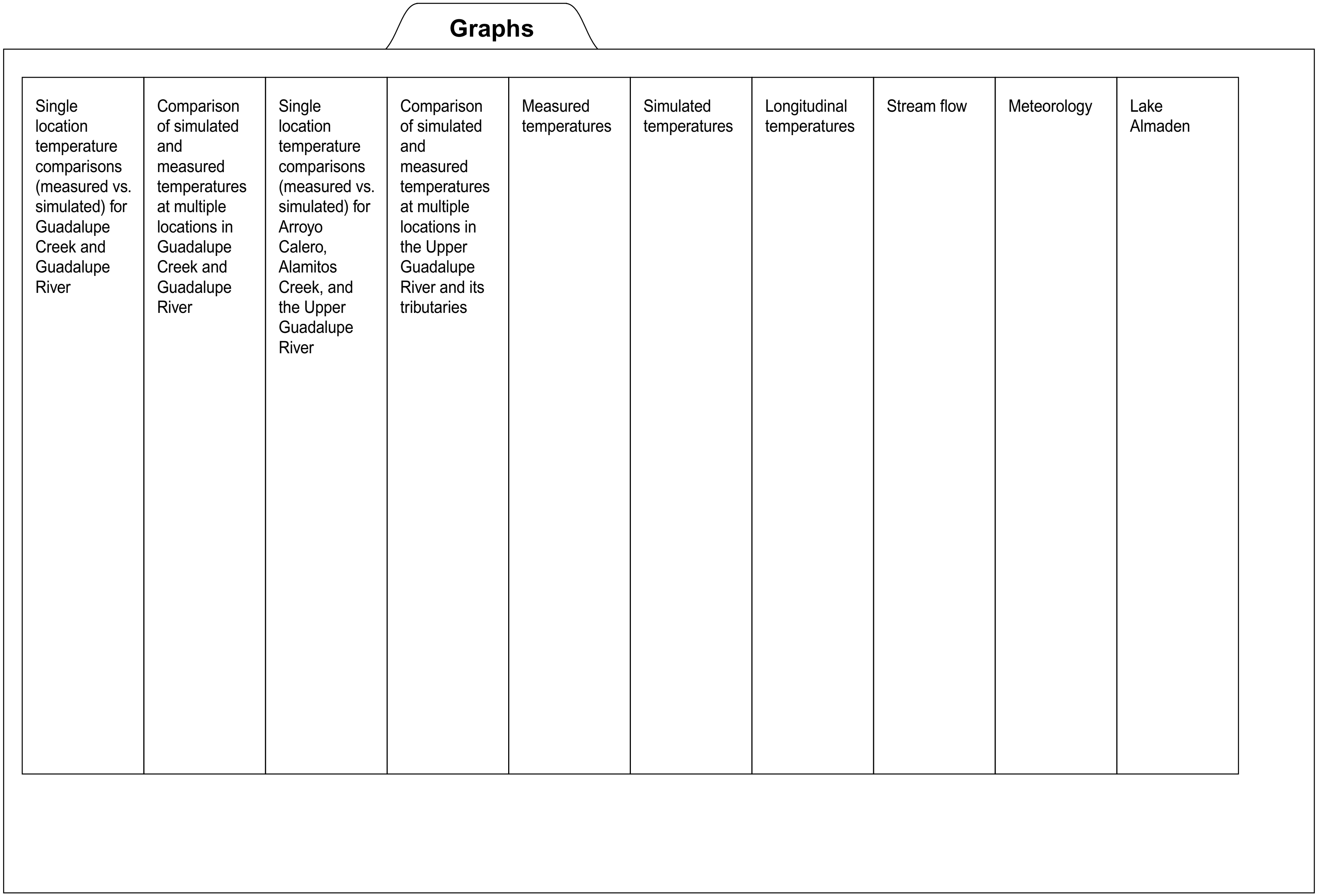

Graphs
Single location temperature comparisons (measured vs. simulated) for Guadalupe Creek and Guadalupe River
Comparison of simulated and measured temperatures at multiple locations in Guadalupe Creek and Guadalupe River
Single location temperature comparisons (measured vs. simulated) for Arroyo Calero, Alamitos Creek, and the Upper Guadalupe River
Comparison of simulated and measured temperatures at multiple locations in the Upper Guadalupe River and its tributaries
Measured temperatures
Simulated temperatures
Longitudinal temperatures
Stream flow
Meteorology
Lake Almaden

Figure H-4
Organization of Sheet "Graphs" in the JSATEMP Stream Temperature Model Spreadsheet

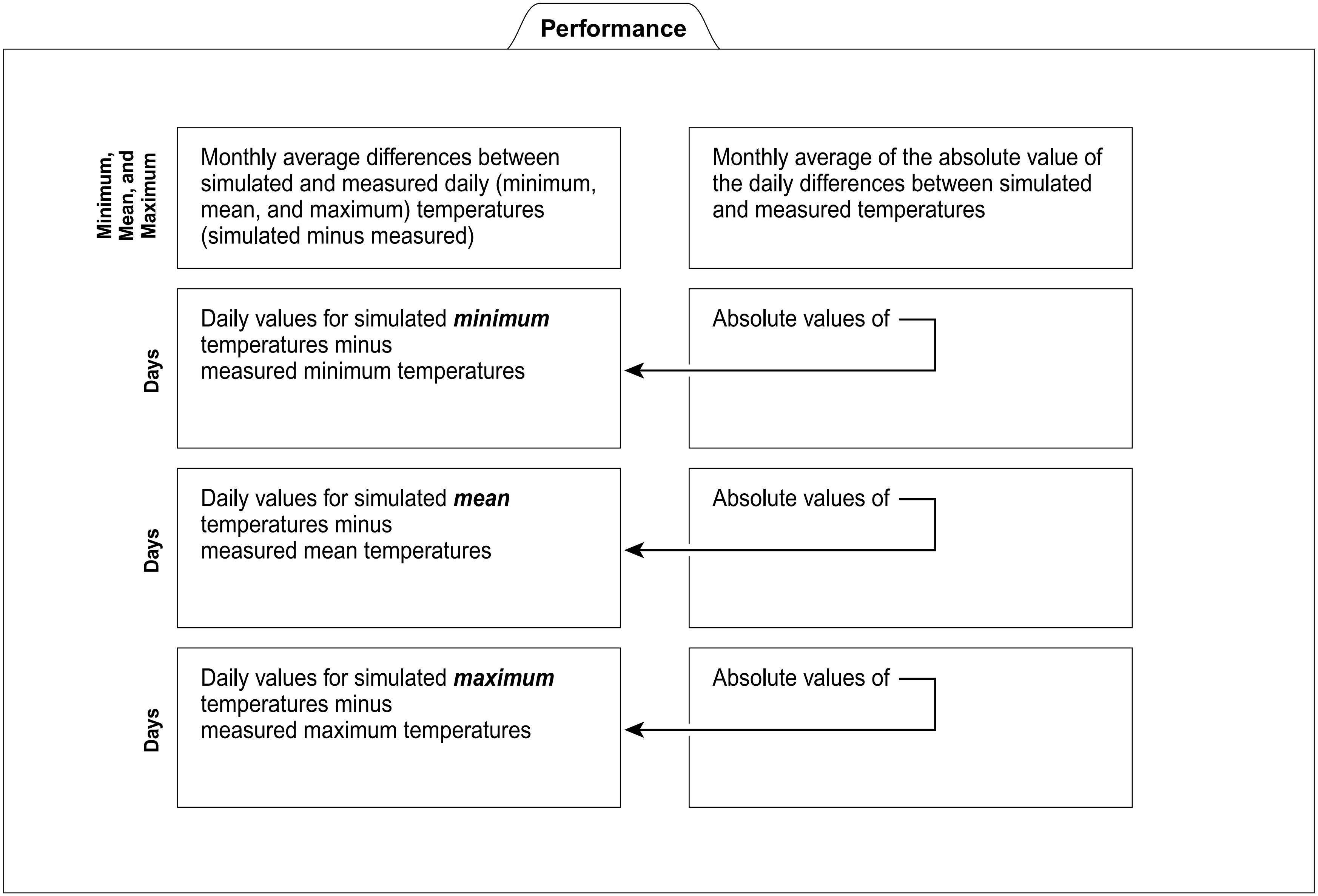

Performance
Minimum, Mean, and Maximum
Monthly average differences between simulated and measured daily (minimum, mean, and maximum) temperatures (simulated minus measured)
Monthly average of the absolute value of the daily differences between simulated and measured temperatures
Days
Daily values for simulated ***minimum*** temperatures minus measured minimum temperatures
Absolute values of
Days
Daily values for simulated ***mean*** temperatures minus measured mean temperatures
Absolute values of
Days
Daily values for simulated ***maximum*** temperatures minus measured maximum temperatures
Absolute values of

Figure H-5
Organization of Sheet "Performance" in the JSATEMP Stream Temperature Model Spreadsheet

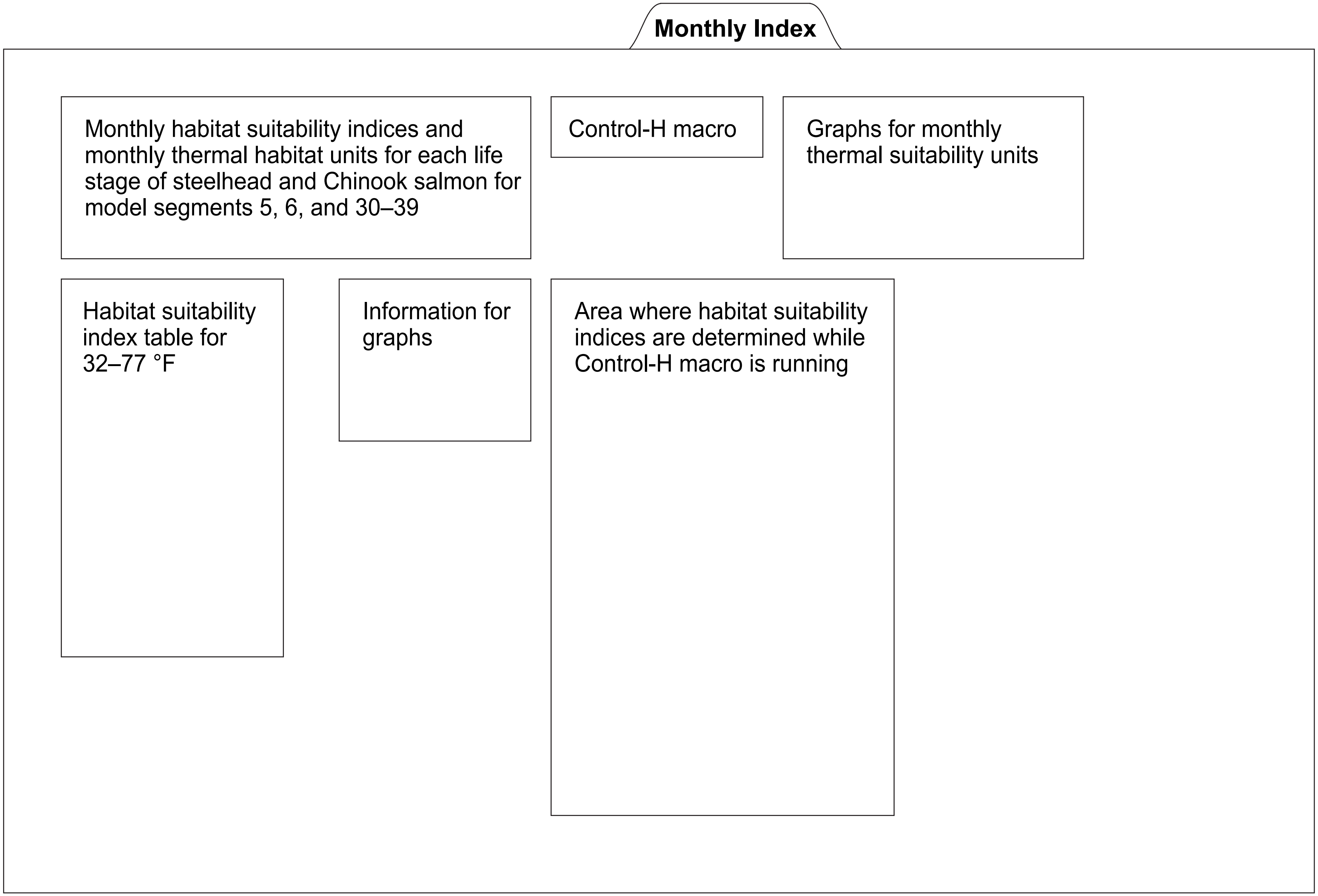

Monthly Index
Monthly habitat suitability indices and monthly thermal habitat units for each life stage of steelhead and Chinook salmon for model segments 5, 6, and 30–39
Control-H macro
Graphs for monthly thermal suitability units
Habitat suitability index table for 32–77 °F
Information for graphs
Area where habitat suitability indices are determined while Control-H macro is running

Figure H-6
Organization of Sheet "Monthly Index" in the JSATEMP Stream Temperature Model Spreadsheet

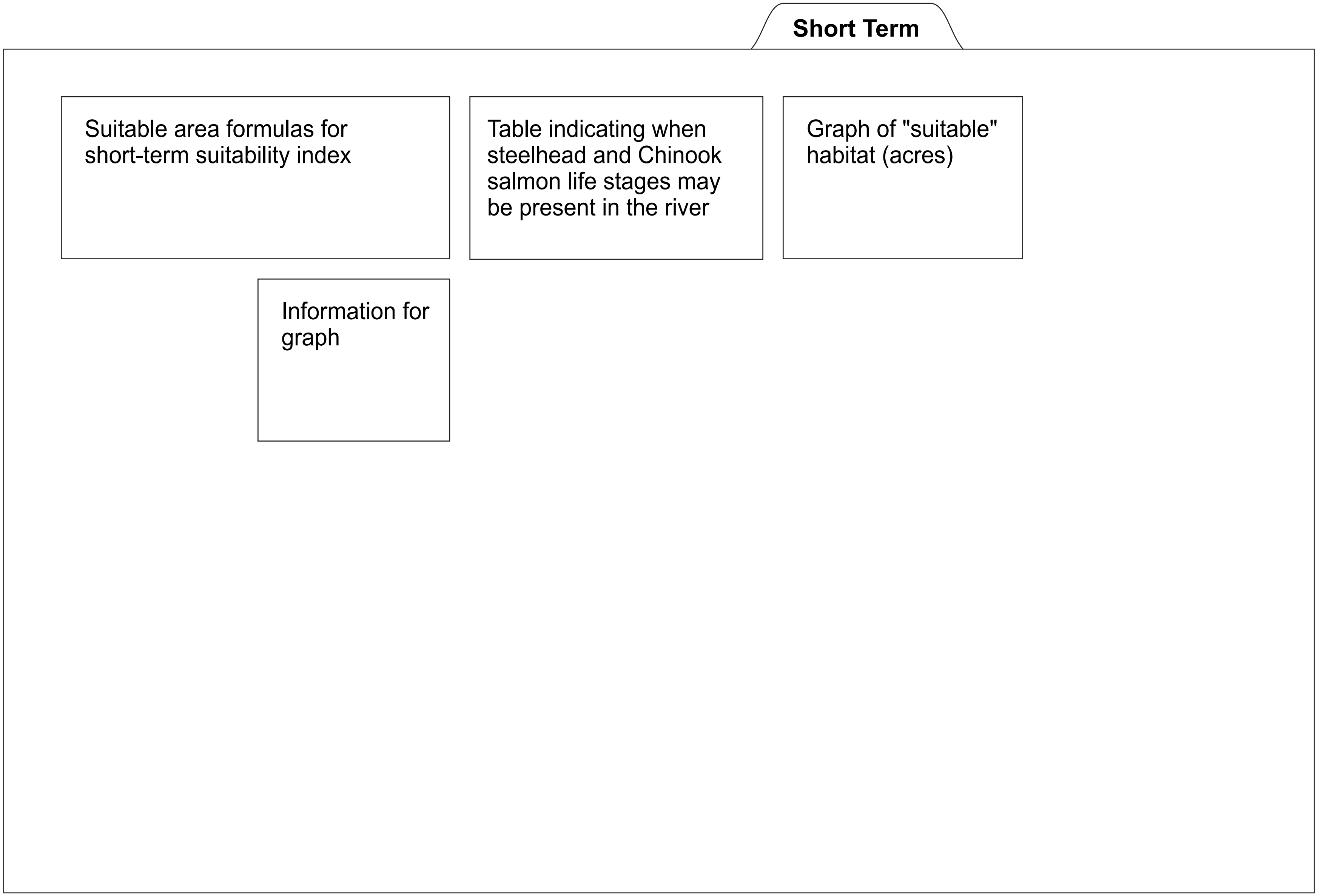

Short Term
Suitable area formulas for short-term suitability index
Table indicating when steelhead and Chinook salmon life stages may be present in the river
Graph of "suitable" habitat (acres)
Information for graph

Figure H-7
Organization of Sheet "Short Term" in the JSATEMP Stream Temperature Model Spreadsheet

have been provided to help the user understand the model layout and navigate through the model.

For the IP, the JSATEMP model will be evaluated by comparing measured water temperature, solar heat transfer, channel geometry, and stream flow to model values. The model will then be used as part of the IP to evaluate water temperature effects associated with construction of the Project. Figures 6-1 and 6-2 show flowcharts of the model analyses for the IP. Figure 6-1 shows the process of evaluating the accuracy of model parameters and predicted temperature using the measured data. Figure 6-2 shows the process of simulating current-postproject and no-project temperatures for the purpose of calculating suitability indicators and determining whether remedial actions for steelhead and Chinook salmon might be needed.

H.2.1 Conventions Used in This Appendix

The following conventions are used in this appendix.

- Two types of segments are discussed in this appendix: Segments and model segments. The first type of segment, *Segment*, is shown in upper case and refers to Project Segments 1, 2, 3A, 3B, and/or 3C. The second type of segment, *model segment*, is shown in lower case and refers to segments used by the JSATEMP model.
- Keystrokes are indicated in bold typeface.
- *Cell* refers to a single cell within the spreadsheet, and *range* refers to multiple cells.
- If a range or cell in the spreadsheet has been assigned a name, it can be located without knowing which sheet it is on. For cell or range addresses that have not been assigned range names, sheet information is provided.
- Named ranges or cell addresses specified in the text can be located in the JSATEMP model by typing **F5** (equivalent to “go to”) and selecting the desired named range or typing the cell address.
- Ranges or cell names are displayed in capital letters (e.g., HOURDATA, DAYDATA).
- Variables and parameters are indicated in italic typeface.

H.3 Developing JSATEMP Stream Temperature Model Inputs

Before simulating temperatures, the user must be sure that the inputs to the JSATEMP model properly reflect what is to be simulated. For example

- to compare simulated to measured temperatures, inputs should reflect the conditions at the time the temperatures were measured;

- to simulate the effect of removing vegetation, the shade parameters should be altered; and
- to simulate the effect of changing the shape of the wetted channel, the channel geometry parameters should be altered.

The JSATEMP model uses three types of input: time-series data, parameters, and variables. Time-series data represent conditions over multiple, regular increments of time (e.g., hourly air temperatures). Parameters represent conditions that affect water temperature and generally do not change with time. Though parameters generally do not vary, they are often used in equations for calculating something that varies with time (e.g., the values used in the equation for calculating channel depth as a function of stream flow). Variables represent conditions that are expected to change occasionally (e.g., the switch that indicates whether flashboards are present on the Alamitos Drop Structure).

The main JSATEMP model inputs are

- hourly meteorology (time-series data),
- daily stream flow data (time-series data),
- shade parameters,
- channel geometry parameters,
- water temperature data (primarily time-series data), and
- values that change monthly (variables).

H.3.1 Meteorological Data and Stream Flow Data

Hourly meteorological data and daily stream flow data should represent the conditions that are to be simulated. For example, to simulate actual water temperatures, use meteorological and stream flow data from the desired dates. To simulate a hypothetical warm or dry year, examine measured meteorology or stream flow for a long period of record and select or create a meteorology or stream flow data set that represents the desired conditions.

To use measured meteorological data, retrieve the following hourly meteorological data from the California Irrigation Management Information System (CIMIS) station at Morgan Hill (station 132): solar radiation, wind speed, air temperature, and dew point temperature. The data are available at http://wwwcimis.water.ca.gov/cimis/welcome.jsp. If meteorological data are measured closer to the Project area in the future, that data should be used. The Morgan Hill meteorological data should be transformed to be more similar to meteorological conditions in the Project area. Data transformation is discussed in the IP (section 6.2.5).

Place the hourly meteorological data under the appropriate column headers in the left side of data range HOURDATA. Column headers indicate the measurement units that should be used.

Stream flow data can be obtained from the Santa Clara Valley Water District (SCVWD). The JSATEMP model uses stream flow data from 11 locations in the Guadalupe River watershed. These locations are listed in table 6-4. The SCVWD collects data at 10 of the locations. Historically, the U.S. Geological Survey (USGS) measured flow in the Guadalupe River at the St. John Street Bridge (gage number 11169000). However, in May 2002, the USGS replaced the St. John Street gage with a gage upstream of Highway 101 (gage number 11169025). Stream flow measurements at the St. John Street gage stopped in September 2002. The JSATEMP model has been modified to use the data from the new USGS location.

Daily flow data from gage 46 and the Almaden Valley Pipeline should also be obtained. Gage 46 measures the flow into the off-stream Los Capitancillos percolation ponds. This flow may come from either Guadalupe Creek or the pipeline. The pipeline flows go either to the off-stream percolation ponds or into Guadalupe Creek. These data are not used directly by the model but can be used to estimate diversions from Guadalupe Creek to the off-stream percolation ponds and to estimate the importation of water from the pipeline into Guadalupe Creek. To make these estimates, it should be assumed that diversions would not be made on the same day that water was being imported.

To obtain the most accurate SCVWD stream flow data, contact the SCVWD at 408/265-2607, rather than obtaining the data from the SCVWD web site. Scott Siegel is the current contact for gage data (extension 2428), and Judy Nam is the current contact for Almaden Valley Pipeline flows (extension 2747). USGS data may be obtained at http://waterdata.usgs.gov/ca/nwis/sw.

Place the daily stream flow data in the data range DAYDATA using the column headers as guides. Guadalupe Creek imports at Masson Dam are specified at range ACRET5, and diversions at Masson Dam are specified at DEPLET5. Procedures for using the gage 46 data and the Almaden Valley Pipeline data are discussed further under “Depletions and Accretions” (section H.3.5.2).

Meteorology and stream flow data need to be complete. Missing data may be filled in using interpolation, data measured at nearby locations, or data measured at the same place at a different time. In addition, data should be checked graphically for errors.

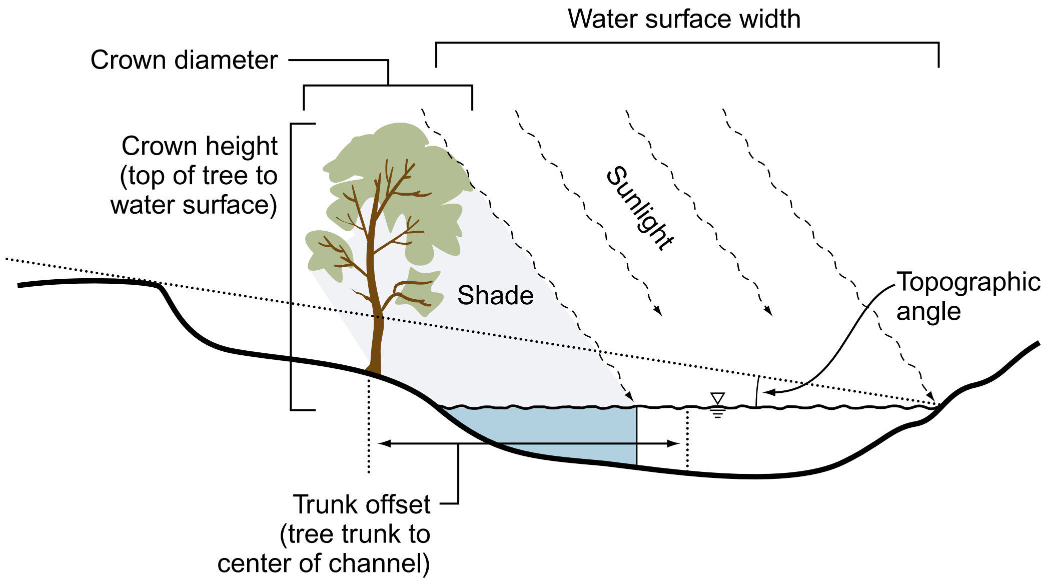
Note: Some stream flow parameters change monthly. These monthly parameters are discussed below in section H.3.5.

H.3.2 Shade Parameters

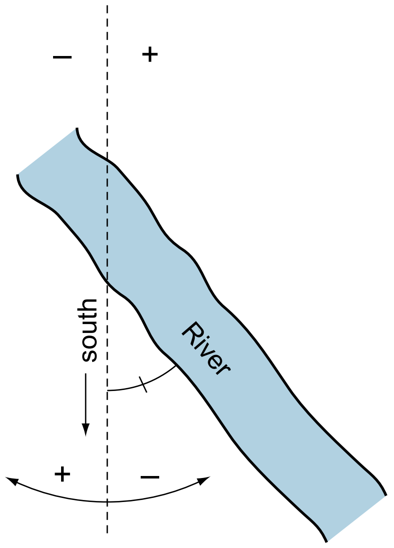
Shade parameters have already been entered in the JSATEMP model. In general, these parameters will not be modified unless 1) data or model results indicate an inaccuracy with existing values or 2) the user wants to simulate a change in the shade conditions. For example, the solar heat transfer measurements for the IP (section 6.2.2) may indicate that the shade parameters in the JSATEMP model should be modified (section H.4.1).

Specific input parameters (and one variable) used in the shade calculations of the JSATEMP model (figure H-8) are listed below. These parameters are included in the JSATEMP model and, all of them, except latitude, stream azimuth, foliage factor, and bridge shade fraction, have values for both banks of the river.

- *Latitude* (37.25°) is a fixed physical parameter.
- *Bridge shade fraction* is the fraction of each model segment covered by bridges. It is a fixed physical parameter. This parameter is also used to simulate the effect of buildings that provide continual shade and the effect of aquatic vegetation shade.
- *Stream azimuth* is the number of degrees from due south that the stream is oriented, with west being positive and east being negative. It is the average direction of the stream. Meanders reduce the effectiveness of this parameter. The azimuth determines whether the east bank shade parameters are to the north or south of the river. Values range from –90 to 90°.
- *Topographic angle*, as determined from the stream edge opposite the bank, is the angle above horizontal where sky becomes visible (assuming no vegetation is present), looking perpendicular to the azimuth direction of the channel (i.e., the angle to the top of the opposite bank).
- *Trunk offset* is the average distance from tree trunks near the stream to the center of the channel. If many trees along a model segment provide shaded riverine aquatic (SRA) cover, the vegetation offset would be relatively small and would correspond to the location of the trees that provide SRA cover. If, however, there is no SRA cover, the vegetation offset would be greater and would represent riparian trees farther from the water.
- *Crown diameter* is the average thickness of the vegetation intercepting the sunlight.
- *Crown height* is the average vertical distance from the top of the trees to the water surface, assuming all trees are along the offset.
- *Foliage factor* is a monthly variable between 0 and 1 that accounts for seasonal change in shade and is used to approximate winter leaf loss. A value of 1 indicates full foliage. For the April–October simulation period, April and October are the only months for which the foliage factor might be less than 1.0. During May–September, the foliage factor is assumed to be 1.0.



Note:
The JSATEMP stream temperature model requires values for both banks.
Values for only 1 bank are depicted in the above figure.



Stream azimuth with
value between –90 and +90

0F028.00-300

Figure H-8
Parameters Used in the Shade Algorithm in the JSATEMP Stream Temperature Model

- *Shade factor parameter* is equal to *linear vegetation fraction* times *shade density*. *Shade factor parameter* is always between 0 and 1.0.
- *Linear vegetation fraction* is the fraction of the model segment that is lined with trees.
- *Shade density* is the average fraction of light screened by trees when the trees have full foliage. Currently, *shade density* is approximately 0.9 for Reach A, Segments 1–3, and Guadalupe Creek.

The fraction of the maximum possible solar radiation that reaches the stream depends on the width of the stream channel and vegetation parameters, as well as the shade factor parameter.

Use the following parameters to adjust the simulated shade values: *bridge shade fractions, topographic angle*, *trunk offset*, *crown diameter*, *crown height*, *foliage factor*, and *shade factor parameter*. *Foliage factor* is located in table LEAFDROP, *bridge fractions* are located in the *bridge fraction* column in the upper portion of sheet “Model,” and the other parameters are located in table SHADEPARAM.

H.3.3 Stream Channel Geometry Parameters

In general, stream channel geometry parameters will not be modified unless 1) data (section H.4.2) or model results indicate an inaccuracy with the existing values or 2) the user wants to simulate a change in the channel shape.

The JSATEMP model assumes that the channel bottom is less steeply curved than the channel banks. The model uses 2 sets of hydraulic geometry equations for each model segment. One set applies when width is less than 25 feet (low flow), and the other applies when width is greater than 25 feet (high flow). The high-flow equations calculate incremental depth and width, which are added to the dimensions of the channel at 25-foot width. Width and depth equations used in the model follow the form

$$Width = C_w + (A_w)(flow^{Bw})$$

$$Depth = C_d + (A_d)(flow^{Bd})$$

When width is less than 25 feet

C_d = the average model segment depth (feet) at 0 flow, called the pool depth because pools contain most of the water at 0 flow;

C_w = the average model segment width (feet) at 0 flow, the pool width; and

Flow = the total flow (in cubic feet per second [cfs]) in the model segment.

When width is greater than 25 feet

C_d = the average model segment depth when the width is equal to 25 feet,

C_w = 25 feet (although for the model segments with a pool width greater than 25 feet, C_w = the pool width), and

Flow = the total stream flow (cfs) in the model segment minus the stream flow required to produce an average model segment width of 25 feet.

Coefficients (A) and exponents (B) are derived from width and depth estimates for 2 different stream flows. The geometry equations in the model can be studied for a more complete understanding of how they work.

Measured stream channel geometry will indicate whether the width or depth parameters need to be adjusted. Model performance (especially diurnal temperature range) may also indicate that channel geometry (especially depth) should be modified.

To adjust the widths and depths consistently for all flows, modify the width and depth constants, C_d and C_w. The easiest way to modify the depth constant for a model segment is to add/subtract a value directly to/from the depth value used by the JSATEMP model, located in range DEPTHS. The easiest way to modify the width constant for a model segment is to add/subtract a value directly to/from the width value used by the JSATEMP model, located in range WIDTHS.

To modify dimensions more at one flow than another flow, modify the coefficients and exponents. Increasing the high-flow coefficients and exponents will cause width and depth to change more at high flows than at low flows. The low-flow and high-flow coefficients and exponents for depth are located in sheet “Model” at range DEPTHCOEFEXP. The low-flow and high-flow coefficients and exponents for width are located in the same sheet at WIDTHCOEFEXP. Modify the high-flow values directly by changing the values of the coefficients and exponents in ranges DEPTHCOEFEXP and WIDTHCOEFEXP. Modify the low-flow values by changing the flow-width and flow-depth estimates located to the left of the coefficients. Changing these estimates will modify the low-flow coefficients and exponents, which are calculated with formulas. The sum of the low-flow width and depth exponents should generally be less than 1.0.

Note that the JSATEMP model has 2 sets of equations for the dimensions of Guadalupe Creek between Masson Dam and Almaden Expressway and for the Guadalupe River between the Alamitos Drop Structure and Branham Lane. The top set (rows 13, 14, 30, and 31) of equations assumes that historical instream percolation ponds are in place; the bottom set of equations does not (rows 51–54).

In addition, the postproject equations for model segment 30, where the trapezoid/boulder low-flow channel is located, follow the same general form as described above but are contained in a single cell for width and a single cell for depth in sheet “Model,” cells SEG30W and SEG30D, respectively. The postproject equations for model segment 30 were developed separately using dimensions from HEC-2 and HEC-RAS simulations of the trapezoid/boulder channel.

H.3.4 Measured Water Temperature

Measured water temperature data are used for 1 of 2 purposes in the JSATEMP model. Depending on where the water temperature was measured, it could be used either for model input or for evaluation of model performance. Temperatures of inflows are used as model input. These inflow temperatures include those measured upstream of simulation areas or those measured at the downstream end of tributaries that are not part of the model. Temperatures measured within the simulation area are used for evaluating model performance.

All hourly measured water temperatures (collected from water temperature loggers, as described in section 6.2.1) for Guadalupe Creek, Alamitos Creek, Arroyo Calero, the Guadalupe River, and the downstream ends of tributaries to these 4 streams should be inserted into the JSATEMP model spreadsheet in range HOURDATA. These data include values for both model input and model evaluation. The column headers in range HOURDATA should be used as a guide for determining where to place the data.

Once all the hourly data have been inserted in the JSATEMP model spreadsheet and graphically checked for errors, convert the hourly values to daily minimum, mean, and maximum values by pressing **Ctrl+D**. If the number of data points during the day is less than the value specified in range COUNTCRIT, no daily minimum, mean, or maximum value will be calculated. The model places the daily values below the hourly values.

H.3.4.1 Water Temperature of Inflows for JSATEMP Stream Temperature Model Input

Water temperatures of JSATEMP model inflows may be adjusted, if there is reason to suspect that the inflow temperatures would change. For example, inflow temperatures may be adjusted to reflect a change in reservoir operations or the shading of a tributary.

The JSATEMP model uses water temperatures for the locations described below as input. Use hourly measured water temperature data collected in the field, as described in section 6.2.1. If hourly measured water temperature data are unavailable from the specified locations (e.g., because of water temperature logger malfunction or loss), estimate the missing water temperature data as described below.

Guadalupe Creek at Masson Dam and Guadalupe River near Grant Street. Temperatures measured at these locations are used for the IP for simulating temperatures in the Project area. When complete sets of hourly data are available for Masson Dam and/or near Grant Street (Virginia Street), place a value of 1 in cells MEAS4 and/or MEAS29. This value tells the JSATEMP model to use measured water temperature data rather than simulated temperatures. If measured water temperature data are not available, leave cells MEAS4 and MEAS29 blank, and the model will use simulated water temperature for model segments 4 and 29 to estimate water temperature entering model segments 5 and 30. If the Virginia Street data are unavailable, model ability to simulate temperatures upstream of Virginia Street, at Willow Glen Way, should be assessed.

Release Temperatures from Almaden, Calero, and Guadalupe Reservoirs. If measured water temperatures for these locations are available, input them in range HOURDATA of the JSATEMP model as the water temperature of the upstream sources for Alamitos Creek, Arroyo Calero, and Guadalupe Creek. When these data are unavailable, estimate the water temperature based on previous water temperature measurements at these locations, either from temperatures measured immediately before and/or after the period of missing data or from temperatures measured at the same time during previous years. Temperature data for water released from Calero and Almaden Reservoirs do not need to be extremely accurate because they have little effect on temperatures in the Project area. In addition, reservoir release temperatures do not need to be accurate if measured temperatures from Masson Dam and Virginia Street can be used for Project area inflow temperatures (i.e., if MEAS4 and MEAS29 are each 1).

Los Gatos Creek. If measured water temperature data from the downstream end of Los Gatos Creek are unavailable, estimate the water temperature based on previous water temperature measurements at this location, either from temperatures measured immediately before and/or after the period of missing data or from temperatures measured at the same time during previous years. These temperatures can also be estimated from the water temperatures measured in the Guadalupe River upstream and downstream of the confluence with Los Gatos Creek, using the following equation:

$$LGtemp = ((DStemp)(USflow+LGflow) - (UStemp)(USflow)) / LGflow$$

Where:

$LGtemp$ = Los Gatos Creek temperature,

$DStemp$ = Guadalupe River temperature downstream of the confluence,

$USflow$ = Flow in the Guadalupe River upstream of the confluence,

$LGflow$ = Los Gatos Creek flow, and

UStemp = Guadalupe River temperature upstream of the confluence.

This equation assumes that the water from Los Gatos Creek has mixed completely with the water from the Guadalupe River by the time it reaches the temperature probe downstream of the confluence.

Local Inflow Temperature. For May–October, local inflows for most model segments are assumed to come from groundwater accretion or similarly cool water. However, the local inflows for model segments 33 and 20–25 are assumed to come from surface water because there are more tributaries and accretions from offstream percolation ponds entering these segments. For the November–April rainy season, all local inflows are assumed to come from surface runoff.

The local inflow temperatures are located in range INFLOT. From May through October, the values for model segments 1–19, 26–32, and 34–39 equal a constant temperature of 65 or 68 °F, predominantly representing groundwater temperature. The local inflow temperatures for model segments 20–25 are formulas that estimate temperatures of local surface runoff. The local inflow temperature for model segment 33 is a formula that links to the measured (or estimated) Los Gatos Creek data. The inflow temperatures were based on a combination of 1996–1997 calibration results and 2001 monitoring results (Jones & Stokes 2002).

When local inflows are assumed to come from surface water, the local inflow temperatures are estimated using hourly water temperatures measured at Airport Parkway. The temperature at Airport Parkway approaches equilibrium values. If water temperature data from Airport Parkway are unavailable, water temperatures measured at other warm locations can be used (e.g., temperatures from the Guadalupe River at the Alamitos Drop Structure).

The cells in the column for local inflow temperature (range INFLOT) are either 65 or 68 °F or they contain the following formula:

@index($HOURDATA, column number,($DAY-1)(24+$HOUR).

Where:

> HOURDATA is the input block for the hourly data,
>
> ($DAY-1)(24+$HOUR is the hour being simulated, and
>
> column number is the column location within the hourly data block of the measured data chosen to represent surface runoff temperatures. By Lotus convention, the first column on the left of a data block is column 0.

The formula for inflow temperatures for model segment 33 (which includes the confluence with Los Gatos Creek) should always refer to the measured values for Los Gatos Creek (see section on Los Gatos Creek above).

H.3.4.2 Water Temperature Data for Evaluating JSATEMP Stream Temperature Model Output

Water temperature data from the Guadalupe River system that are not used as input to the JSATEMP model should be inserted in the model spreadsheet (in range HOURDATA) to evaluate the model's accuracy in simulating actual conditions. Because these water temperatures are not required input to run the model, it is not necessary to fill in missing data.

H.3.5 Parameters That Change Monthly

Parameters that change monthly are foliage factor, depletions, instream percolation ponds, location of Guadalupe Creek outlet, presence/absence of flashboards at the Alamitos Drop Structure, and initial values for the first hour of the month.

H.3.5.1 Foliage Factor

Range LEAFDROP specifies the monthly foliage factor values, which are also described above in the shade parameter section (H.3.2). These values represent the fraction of riparian shade that is present for the month. When all the leaves are on the trees, the value should be 1.0. In the middle of winter, the riparian vegetation is estimated to have a foliage factor of 0.2 (based on observation and model calibration). LEAFDROP contains values for each month of the year. Users may change these values if they believe that the loss or regrowth of foliage has occurred at a different time of year or that the winter value of 0.2 is incorrect.

H.3.5.2 Depletions and Accretions

Depletions are stream flow losses, usually caused by diversion or percolation. Accretions, in contrast, occur when there is an increase in stream flow. For each model segment, the JSATEMP model uses gage flow data to determine which model segments have accretions and which have depletions. It calculates a depletion/accretion based on the length of the model segment and the amount of water that is lost between 2 or 3 gage locations.

For model segments 5, 6, and 18, however, the loss rate (cubic feet per second lost per mile) is higher than for adjacent segments because of flow lost to percolation pond diversions and instream percolation. To account for these higher loss rates, additional depletions for model segments 5, 6, and 18 are entered by the user in cells DEPLET5, DEPLET6, and DEPLET18, respectively. When the higher losses are specified, the model adjusts the general loss rate for all the model segments in a section of river, so that the modeled flow at the gage locations will still be the same as those specified as time-series input. For example, if the model input values for flow are 15 cfs for Alamitos Creek at

Greystone Bridge, 10 cfs for Guadalupe Creek at Masson Dam, and 15 cfs at the Alamitos Drop Structure, these values imply that 10 cfs are lost in the lower part of Alamitos and Guadalupe Creeks and the upper part of the Guadalupe River. If there are no specific accretions or depletions, this 10-cfs loss is distributed between the model segments located between these gages. If, however, DEPLET5 is set to 7 cfs, the remaining loss to be distributed between the model segments would only be 3 cfs.

The depletion value for model segment 5 represents water that is diverted at Masson Dam for the Los Capitancillos percolation ponds. The value for model segment 5 also includes percolation that is above the percolation rate typically seen in lower Guadalupe and Alamitos Creeks. The value for model segment 6 represents excess instream percolation rates. The value for model segment 18 represents water that is diverted upstream of the Alamitos Drop Structure for the Alamitos percolation ponds.

Diversions can be estimated using stream flow data measured at the SCVWD gages. For example, if stream flows are at 15 cfs in Alamitos Creek, 6 cfs in Guadalupe Creek upstream of Masson Dam, and 10 cfs at the Alamitos Drop Structure (downstream of the Alamitos/Guadalupe Creek confluence), 11 cfs have been lost from the system. No more than 6 cfs could have been diverted from Guadalupe Creek (because the creek flow was only at 6 cfs); the rest could have been diverted from model segment 18. In addition, the flows measured for the IP (section 6.2.4) can provide direct information on the loss rate within lower Guadalupe Creek for the days that stream flow is measured.

In addition to the depletions from model segments 5, 6, and 18, the JSATEMP model also provides the ability to modify monthly depletions in model segments 4, 17, 19, and 20 and accretions in model segments 5, 6, 17, and 19. Most of these values, however, typically are not modified. The accretion for model segment 19 is left at a constant 2.0 cfs, to represent accretions from the off-stream percolation ponds. Accretions in model segment 17 and depletions in model segments 17, 19, and 20 are left at 0 because there is no evidence that they should differ from the other model segments. The accretions for model segments 5 and 6 and depletions for model segment 4 are considered to be small (less than 1 cfs) and can be estimated from the field-collected stream flow measurements, although it is difficult to assign accretion values if depletions are occurring in the same model segment (e.g., model segment 6). If water is imported to Guadalupe Creek at Masson Dam, it should be included in the value for the accretions for model segment 5 (ACRET5).

Diversions at Masson Dam (the upstream end of segment 5) can be estimated as equal to daily flow at gage 46 (inflow to the Los Capitancillos percolation ponds) minus daily flow in the Almaden Valley Pipeline turnout at Masson Dam. If the pipeline flow is greater than the gage 46 flow, the extra pipeline water can be assumed to be imported to Guadalupe Creek. A formula can be entered at cells ACRET5 and DEPLET5 that will use the daily diversion or import values.

H.3.5.3 Instream Percolation Ponds

The JSATEMP model has a switch at cell INPERC to indicate whether the instream percolation ponds that were historically used in the lower Guadalupe Creek and downstream of the Alamitos Drop Structure are in operation. This switch controls which channel geometry values are used for model segments 5, 6, 19, and 20, where percolation ponds were located. Leave this switch at 0 to indicate that no instream percolation ponds are in use, unless SCVWD begins operating these ponds. Set cell INPERC to 1 if the instream percolation ponds are used.

H.3.5.4 Guadalupe Creek Outlet

The outlet of Guadalupe Creek is at the downstream end of Almaden Lake, near the boundary of model segments 17 (Almaden Lake) and 18. The path of the Guadalupe Creek water once it enters the Guadalupe River is uncertain. If cell GC is set to 1, the JSATEMP model simulates Guadalupe Creek as entering Almaden Lake (model segment 17). If cell GC is set to 0, the model simulates Guadalupe Creek as entering model segment 18.

The presence or absence of the flashboards at the Alamitos Drop Structure has been used to estimate whether Guadalupe Creek water flows into model segment 17 or downstream into model segment 18. When the flashboards are in place, water backs up behind the Alamitos Drop Structure, essentially extending Almaden Lake through model segment 18. The flashboards are usually in place only from midspring to midfall, when flows are generally low. During this period, water from Guadalupe Creek has been assumed to flow into model segment 17 (Almaden Lake) by setting GC equal to 1. At night, when Guadalupe Creek is relatively cool, the creek flows to the bottom of Almaden Lake. When the flashboards are removed, Guadalupe Creek has been assumed to flow into model segment 18 (i.e., GC set to 0) because the Guadalupe River near the mouth of the creek is shallower and flows faster.

H.3.5.5 Flashboards at the Alamitos Drop Structure

The depth and width of model segments 17A (top of Almaden Lake), 17B (bottom of Almaden Lake), and 18 depend on whether flashboards are present at the Alamitos Drop Structure. The elevation of the lake surface is typically raised 5 feet in the summer when the flashboards are in place. For the model to use the correct dimensions, put the correct value in range FLASHBRDS to specify whether the flashboards are in place during the month, out during the month, removed during the month, or installed during the month (values to use are specified in the model). If the flashboards are removed or installed during the month, use range CHANGEDATE to indicate the day of the change.

H.3.5.6 Initial Values

The JSATEMP model needs initial values for the first hour of the month for water temperature and sediment temperature. If available, the water temperatures and sediment temperatures from the end of the previous month should be entered as the initial values for the current month. These values are located in ranges INT and INTSED. If multiple consecutive months are to be simulated, a macro can be used to automatically run the simulation for each month and place the temperatures at the end of one month into the beginning of the next month. If the values for the previous month are unavailable, initial water temperatures should be estimated from measured water temperatures at the beginning of the month, and initial sediment temperatures should be set equal to the initial water temperatures.

H.4 Evaluating JSATEMP Stream Temperature Model Components for the Implementation Plan

As part of the IP, solar heat transfer, stream channel geometry, and stream flow will be measured (sections 6.2.2, 6.2.3, and 6.2.4, respectively). These measurements will be used to evaluate the accuracy of the JSATEMP model components for shade, stream channel geometry, and stream flow.

H.4.1 Heat Transfer

In areas where vegetation is believed to have changed, the new estimates of the shade parameters (section H.3.2) should be inserted in the JSATEMP model prior to evaluating model estimates of shade. Field surveys and aerial photographs are used for the heat transfer measurements to estimate the measured terrestrial vegetation, aquatic vegetation, building, and topographic shade fractions that correspond to the time the photographs were taken (section 6.2.2).

Terrestrial vegetation shade and topographic shade fractions are not inserted directly into the JSATEMP model. Instead, the model calculates these values using the shade parameters. To determine the terrestrial vegetation and topographic shade fraction estimated by the model, run the shade macro. This macro and its output are located on sheet “Shade.” Before running this macro, go to ranges MONTH and DAY and specify the value corresponding to the time that the aerial photographs were taken. Next, make sure that the flows for the month are correct because these flows will determine the stream width. Next, type **Ctrl+S** to run the macro. The model calculates the vegetation shade fraction and inserts the results in a table starting at cell VEGSHADE in sheet “Shade.” The table with estimated topographic shade fractions starts at cell TOPOSHADE in sheet “Shade.”

Compare the measured terrestrial vegetation, building, and topographic shade fractions for each model segment (section 6.2.2) to the vegetation and topographic shade fractions simulated by the JSATEMP model for the date and time corresponding to the measurement.

If the modeled shade fractions are substantially different (i.e., more than 10%) from the measured shade fractions, adjust the JSATEMP model parameters. For example, if the measured shade is 0% and the modeled shade is 2%, no adjustment is needed, but if the measured shade is 0% and the modeled shade is 11%, adjustments should be made to the model parameters for shade. The shade parameters are discussed above in section H.3.2. The results of tree height and SRA cover monitoring, analysis of shaded stream surface, and measurements and notes for solar heat transfer provide the basis to modify shade parameters. Reevaluation of the aerial photographs taken for the SRA cover and solar heat transfer measurements may also be useful for adjusting shade parameters.

Building shade is not an explicit part of the JSATEMP model. Account for measured building shade fractions in the model by augmenting either the model vegetation shade fractions or the model bridge shade fractions. Continuous building shade should be added to the bridge fraction, whereas transient building shade should be incorporated in the vegetation parameters. Building shade has already been added to the model and will not change unless a new large building is constructed close to the channel.

The aquatic vegetation shade fractions are inserted directly in the model by adding them to the model bridge shade fractions. These values vary monthly and are determined by combining the growth pattern information from the aquatic vegetation shade transects with the information from the aquatic vegetation shade coverage determined from the aerial photographs (section 6.2.2.7).

H.4.2 Stream Channel Geometry

The measured stream channel geometry (section 6.2.3) must be compared to the stream channel geometry calculated by the JSATEMP model using the stream flow data. To compare measured stream channel geometry values to those estimated by the JSATEMP model, use the following steps.

1. Enter stream flows measured during channel geometry monitoring into range FLOW.

Warning: *If the model spreadsheet is saved with these flow values, the flow formulas that were in these cells will be lost.*

2. Press **F9** (recalculate), and the JSATEMP model will recalculate the stream depth and width for the stream flow values.

3. Compare the modeled and measured depths and widths.

If the JSATEMP modeled depths and widths differ from the measured depths and widths by more than 10%, adjust the modeled values by changing the parameters in the width and depth equations (section H.3.3). The parameters to modify will depend on the channel shape and flow at the time of the measurements. Flows should be low when channel geometry is measured. At low flows, the depth and width at 0 flow (i.e., the constants C_d and C_w) usually make up most of the width and depth and are likely candidates for modification. The low-flow coefficients and exponents may also be modified. If the width at low flow is greater than 25 feet, the high-flow coefficients and exponents are used by the model and may be modified.

H.4.3 Stream Flow

The purpose of this evaluation is to check the JSATEMP model assumptions for accretions and depletions that occur between the stream gages. Compare stream flow data measured during the channel geometry surveys and during the monthly stream flow surveys (section 6.2.4) to stream flow results estimated by the model. The model estimates flows at the downstream end of each model segment based on stream gage data. The model flows for the segments corresponding to gage locations should match the gage measurements exactly, but the model flows might not exactly match the flows measured between the gages. Do not make the comparison if the stream flow measurements occurred during a period of rapidly changing flow, such as during or after a storm event. The model calculations of accretions/depletions during periods of high variability are expected to be inaccurate.

To make this comparison, the gage flow data should be entered in the model at range DAYDATA. In addition, the proper flow value must be entered within range FLOW for the Alamitos Drop Structure (SCVWD gage 20, model segment 18). This last step is required because the model calculates Almaden Lake releases only as the model is actively running. Next, enter the correct value for MONTH and DAY and hit F9 for recalculate.

If the simulated stream flows (in range FLOW) are more than 10% different from the measured flows, the accretion and depletion calculations may be modified by altering the equations in sheet "Model" in ranges INFLOWOUTFLOW and ACRETDEPLET. In addition, stream flows in lower Guadalupe Creek can be adjusted by modifying the monthly diversions and accretions specified for the creek (section H.3.5.2), located in sheet "Model" in range GC_ACRETDEPLET.

H.5 Running the JSATEMP Stream Temperature Model

The model is ready to be run when

- the time-series data for stream flow, temperature, and meteorology have been inserted in the JSATEMP model;

- stream flow, shade, and channel geometry parameters have been evaluated if conditions have changed (e.g., mitigation plantings have grown) and have been evaluated against recently measured data;
- the values for monthly parameters have been selected; and
- the water temperature and sediment temperature values from the end of the previous month have been entered as the initial values for the first month of the simulation period (in ranges INT and INTSED).

To run the model for a particular month, follow the steps below.

1. Enter the month number in cell MONTH (e.g., January = 1). If the month is February of a leap year, enter 29 for February in table MONTHNAME, otherwise MONTHNAME should remain unchanged.

2. Type a description of the simulation being performed in cell DESCRIPT. This description will be inserted in many of the graphs.

3. Press **Ctrl+T**. The day simulated is indicated in the upper status bar. Simulated hourly temperatures will be placed in HOURTEMP, and simulated daily minimum, mean, and maximum water temperatures will be placed below the simulated hourly temperatures.

If multiple months are to be simulated, a macro can be used to perform the above steps sequentially for each month. In addition, such a macro can be used to make changes to model spreadsheets, which is particularly useful if multiple spreadsheets are to be changed.

H.5.1 JSATEMP Stream Temperature Model Commands

The following is a list of commands for running auxiliary model functions.

Ctrl+D converts hourly measured data to daily minimum, mean, and maximum values. Run this macro command once after the measured hourly data have been entered in the JSATEMP model (section H.3.4).

Ctrl+M saves current results so that they will not be erased when the model is rerun. This macro is useful for model calibration (section H.6).

Ctrl+S evaluates the modeled shade conditions for a particular day. This macro is useful for comparing simulated solar radiation reaching the water to measured heat transfer data (section H.6).

Ctrl+I imports daily stream flow data from a master flow file. This macro is available as a convenience; it is not necessary to keep stream flow records in a master file or to use this macro. The master flow file is created by putting all of the daily stream flow data for a year into a spreadsheet and assigning the names JANIN through DECIN to each block of monthly data. The flow data must be in the same order as it appears in the model in range DAYDATA. To use the Ctrl+I macro, the proper name of the master flow file must be inserted into the macro at cell FLOWFILE in sheet "Model."

Ctrl+H calculates the monthly thermal suitability index from the simulated hourly temperatures. It is generally not necessary to use **Ctrl+H** because the Ctrl+T master program runs this routine when all the hourly temperatures have been calculated. Use **Ctrl+H** if a parameter that might affect the monthly thermal suitability index is altered without any changes that would necessitate resimulating temperatures with **Ctrl+T**. The short-term thermal suitability values are calculated by the JSATEMP model using formulas, so it is not necessary to run a macro to recalculate values for short-term thermal suitability.

H.6 Evaluating the JSATEMP Stream Temperature Model Performance and Making Adjustments

Prior to simulating project-related temperature effects, the ability of the JSATEMP model to properly simulate temperatures needs to be evaluated. Assess model performance when new measured temperature data become available or when parameters in the model are changed. For the IP, when measured water temperature data have been downloaded for April–October, compare simulated water temperatures for the April–October flow and meteorology to the new measured water temperature data. Section 6.3.2.2 describes how to determine whether the model is performing satisfactorily.

The JSATEMP model has 2 comparison tools for evaluating results. These tools are graphs created to compare the measured and simulated water temperatures and tables created to summarize the differences between the simulated and measured daily minimum, mean, and maximum water temperatures. These comparison tools are located on the sheet "Calibrate." Given the variability and uncertainty of model inputs, simulated water temperature will never exactly match measured water temperature.

A minimum amount of data is necessary before results are reported in the comparison tables. The value at range PERFCRIT specifies the number of days of measured data within the month that are required for the average monthly differences between measured and simulated minimum, mean, and maximum daily temperatures to be reported. For example, if there are only 5 days of measured data for the Guadalupe River at Coleman Avenue, the model user may not want to use this limited data set to evaluate the model's ability to simulate temperatures at Coleman Avenue for the month. A PERFCRIT value of 20 would exclude comparison of locations with fewer than 20 days of measured values from the monthly difference tables.

If the model performance is unsatisfactory, adjustments will be necessary. An important step in adjusting a model is to evaluate the manner in which its simulations deviate from the measured values. For example, if daily temperature fluctuations are too great in a particular model segment when flows are relatively high, the estimated segment depth at the high flows may be too shallow.

To adjust the JSATEMP model, modify the parameters with the greatest uncertainty and with the greatest potential to improve results. During previous calibration work, values that were altered included

- depth and width equations,
- local inflow temperatures,
- diversions, and
- shade parameters.

Previous calibration work is described in more detail in *Simulation of Temperature Impacts and Associated Mitigation Measures for the Guadalupe River Project, Downtown San Jose, California* (U.S. Army Corps of Engineers, 2004) and in *Water Year 2001 Mitigation Monitoring Report for the Guadalupe River Project* (Jones & Stokes 2002). With ongoing data collection (temperature, stream flow, depth, width, and heat transfer) for the IP, the parameters that control these values will become more accurate over time, and fewer calibration adjustments will be required.

If local accretions/depletions, channel dimensions, and shade parameters are known with some certainty, another possible parameter to adjust is local meteorology. Currently, the JSATEMP model applies the San Jose CIMIS meteorology to all model segments, even though air temperature, wind speed, and dew point temperature vary locally. The SCVWD has collected air temperature data at multiple locations in the Guadalupe system, and such data could be used to adjust air temperatures on a model-segment-by-model-segment basis, if simulated temperatures for some model segments are regularly either too high or too low.

New information may also help to indicate how the JSATEMP model could be adjusted. Below are some examples of how particular information might lead to model adjustments.

- If daily information on diversions from Guadalupe Creek or Guadalupe River becomes available, the model could be modified to use such values instead of using the estimated average monthly diversions.
- If evidence indicates that the assumptions about the outflow location of Guadalupe Creek are incorrect, the outflow location for Guadalupe Creek may be modified. Such evidence could include measured temperatures in the vicinity of the creek or dye studies.
- If the solar heat transfer, stream channel geometry, and stream flow measurements discussed in section H.3 indicate that the values calculated by the shade, channel geometry, or flow components of the model are incorrect, the parameters that control these calculated values should be modified.

One challenging aspect of temperature simulations and model adjustments is that changes that improve JSATEMP model performance for a particular segment may also affect the results for downstream model segments. In addition, improvements for 1 month could affect model performance for other months. When adjustments are performed, model changes should be evaluated by applying the changes to other months that have been simulated. Adjustments should be evaluated by rerunning the model for all prior months for which the change in parameters is applicable. For example, if collected channel geometry values show that the channel geometry parameters should be modified, the effect of changing channel geometry parameters should be evaluated for as far back in time as it is likely that the geometry was unmodified (e.g., prior to a major flow event or Project modification of the low-flow channel). In contrast, measured shade values examined in September may indicate that shade parameters should be changed, but if the shade condition was known to have changed in July as a result of vegetation removal, it is only necessary to reevaluate as far back as July.

H.7 Evaluating Project Effects

H.7.1 Simulating Current-Postproject and No-Project Temperatures

Once the Project has been constructed, simulated current-postproject and no-project water temperatures will need to be evaluated. Simulations will be made for the months that are of most concern to steelhead and Chinook salmon (April–October) for as long as the Adaptive Management Team considers them necessary.

Current-postproject temperatures represent current conditions and are simulated during the model evaluation/calibration process.

For the no-project simulation, the JSATEMP model will simulate water temperature for current meteorology and stream flow but will use preproject shade and stream channel geometry. To simulate no-project conditions, preproject channel geometry and shade conditions must be entered in the model spreadsheet that was used to simulate current-postproject conditions. The preproject values are already in the current version of the no-project spreadsheets. The preproject parameters were developed for the environmental impact report/environmental impact statement for the Guadalupe River Project (U.S. Army Corps of Engineers, 2001) and were modified as described in the *Final Water Year 2001 Mitigation Monitoring Report for the Guadalupe River Project, Downtown San Jose, California* (Jones & Stokes, 2002) and *Final Water Year 2002 Mitigation Monitoring Report for the Guadalupe River Project, Downtown San Jose, California* (Jones & Stokes, 2003).

Save the JSATEMP model spreadsheets using the format “mmmyynp.wk4” or “mmmyycpp.wk4,” where

- month is substituted for “mmm” (for example, “Jan”),
- year is substituted for “yy” (for example, “02”), and
- current-postproject is represented by “cpp” or no-project is represented by “np.”

Create a CPP and NP spreadsheet for 7 months (April–October) of each year until the Adaptive Management Team determines that this monitoring is no longer necessary.

H.7.2 Monthly Thermal Suitability Indicator

For the IP, the purpose of the monthly thermal suitability indicator is to assess long-term effects of water temperature changes on steelhead and Chinook salmon life stages. The JSATEMP model calculates the monthly thermal suitability indicator by using the simulated hourly water temperatures for current-postproject and no-project conditions. The model calculates monthly thermal suitability units (TSUs) for model segments 5, 6, and 30–39 and then totals all values to produce the total monthly TSUs. The total units are used as the indicator. Monthly TSUs provide a common unit of currency that enables accounting for improved water temperature conditions in some stream reaches and degraded water temperature conditions in other stream reaches. This indicator provides a general assessment of water temperature conditions for each species and life stage of fish.

The JSATEMP model calculates monthly TSUs (section 6.4) and inserts them in table MINDEX. To assess whether the measurable objective for the monthly thermal suitability indicator has been met, compare the monthly thermal suitability indicator for current-postproject conditions to the monthly thermal suitability indicator for no-project conditions. To meet the measurable objective for the monthly thermal suitability indicator, the current-postproject values of this indicator for steelhead and Chinook salmon life stages should equal or exceed the no-project values by monitoring year 40. The monthly thermal suitability indicator is discussed in more detail in the IP.

H.7.3 Short-Term Thermal Suitability Indicator

The purpose of the short-term thermal suitability indicator is to assess the surface area of stream that provides suitable water temperatures for each life stage of steelhead and Chinook salmon. The JSATEMP model calculates the components of the short-term thermal suitability indicator for each life stage of steelhead and Chinook salmon present in the river. The short-term thermal suitability indicator will help enable the National Oceanic and Atmospheric Administration National Marine Fisheries Service and the Adaptive Management Team to determine the need for remedial actions in the short term, prior to the maturity of SRA cover vegetation and riparian vegetation.

The short-term thermal suitability indicator will be calculated for the current year (current-postproject) and predicted for the subsequent year (future-postproject). Subsequent-year predictions will be made using current-year hydrology and meteorology, along with predicted construction effects to channel geometry and shade. Evaluation of the subsequent-year predictions will also include general assessment of the potential effects of variability in meteorology (section 6.5.3.4).

Save the future-postproject JSATEMP model spreadsheets using the format "mmmyyfpp.wk4," where

- month is substituted for "mmm" (for example, "Jan"),
- year is substituted for "yy" (for example, "02"), and
- "fpp" is future-postproject (i.e., for future-postproject conditions).

Create a FPP spreadsheet for 7 months (April–October) of each year as long as project actions planned for the next year may cause an increase in water temperatures.

The JSATEMP model calculates the total suitable area within the primary model segments affected by the Project (model segments 5, 6, and 30–39) for each life stage of steelhead and Chinook salmon. These values are located at range SHORTTERM. The calculation procedure used by the model and the definition of *suitable* are described in section 6.5. The calculations are in the current-postproject, future-postproject, and no-project spreadsheets for April–October. The short-term thermal suitability indicator is the current or future-postproject stream surface area that is considered suitable divided by the no-project stream surface area that would have been considered suitable. The result is presented as a percentage. For spawning steelhead and Chinook salmon, the analysis is also performed using spawning gravel area (as well as stream surface area).

To meet the measurable objective for the short-term thermal suitability indicator, the stream surface area or spawning gravel area with suitable temperatures under current-postproject and future-postproject conditions should be equal to or greater than 50% of the stream surface area that would have provided suitable water temperatures under no-project conditions for present stream flow and meteorology.

The suitable surface areas for individual model segments are located in range SHORTTABLE. The values for individual segments may be important because they can help to determine whether a failure to meet the short-term measurable objective warrants remedial action.

The measurable objective for the short-term thermal suitability indicator should be met every month for at least the first 10 years following Project construction. If this objective is not met, the Adaptive Management Team will evaluate the reason for the failure to meet the measurable objective and determine whether remedial action is necessary. Remedial action may not be necessary if the cause of the failure to meet the objective is determined to be of minor significance.

H.8 References Cited

Jones & Stokes. 2002. *Water year 2001 mitigation monitoring report for the Guadalupe River Project, downtown San Jose, California*. Final. August. (J&S 02-076.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA, in coordination with Santa Clara Valley Water District, San Jose, CA.

—————. 2003. *Water year 2002 mitigation monitoring report for the Guadalupe River Project, downtown San Jose, California*. Final. February. (J&S 02-550.) Sacramento, CA. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA, in coordination with Santa Clara Valley Water District, San Jose, CA.

U.S. Army Corps of Engineers. 2001. *General reevaluation report/environmental impact report/supplemental environmental impact statement.* Sacramento, California. Prepared by Santa Clara Valley Water District (San Jose, CA), CH2M HILL (Sacramento, CA), and Jones & Stokes (Sacramento, CA).

—————. 2004. [In prep.] *Simulation of water temperature for the Guadalupe River flood control project located in downtown San Jose, California.* Prepared by Jones & Stokes, Sacramento, CA.

Appendix I

Supplemental Biological Opinion for the Guadalupe River Project from the National Oceanic and Atmospheric Administration National Marine Fisheries Service

Dated October 28, 2003

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802- 4213

OCT 28 2003

In Response Refer To:
151422SWR02SR8444:GRS

Kenneth E. Hitch, P.E.
Chief, Planning Division
Sacramento District, USACE
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Hitch:

Enclosed is the National Marine Fisheries Service's (NOAA Fisheries) supplemental biological opinion for the reinitiation of consultation on the Guadalupe River Project in downtown San Jose, California (Project). The supplemental opinion addresses the proposed fisheries monitoring program for the Project.

The original biological opinion issued on August 11, 2000, and amended on May 30, 2001, analyzed the effects of the proposed flood control project on Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*). Concurrently, NOAA Fisheries provided Essential Fish Habitat (EFH) Conservation Recommendations pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) for fall-run Chinook salmon in the Guadalupe River. During the initial consultation, the Project's Mitigation and Monitoring Program proposed a fisheries monitoring program for anadromous salmonids, but several program details including sampling locations, timing, and methods had not been developed. As a result, the August 11, 2000, biological opinion and EFH Conservation Recommendations could not fully analyze the potential effects of the fisheries monitoring program. By letter dated July 16, 2002, the Corps provided NOAA Fisheries the *Final Proposed Anadromous Fish Monitoring in the Guadalupe River Watershed and Related Potential Take of Steelhead.* The enclosed supplemental biological opinion evaluates the effects of the proposed fisheries monitoring program on CCC steelhead.

Based on our review of the proposed fisheries monitoring program and the anticipated levels of take, the supplemental biological opinion concludes that the proposed program is not likely to jeopardize the continued existence of the threatened CCC steelhead. The analysis in this opinion supplements the analysis completed in the August 11, 2000, opinion and is intended to complement, not replace, that opinion. NOAA Fisheries believes the action is likely to result in take of CCC steelhead, and therefore, an incidental take statement is included with this supplemental biological opinion. The incidental take statement replaces the incidental take statement issued for this project on August 11, 2000, and amended on May 30, 2001. EFH Conservation Recommendations provided under section 305(b)(2) of the MSFCMA on August 11, 2000, and amended on May 30, 2001, have not been modified or changed as a result of the fisheries monitoring program. Thus, EFH Conservation Recommendations for the Project are not repeated here.

Thank you for your continued coordination and cooperation on this project. If you have questions regarding the supplemental biological opinion, please contact Gary Stern of my staff at 707-575-6060.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Acting Regional Administrator

Enclosure

cc: Jim Lecky, NOAA Fisheries
Dave Chesterman, Santa Clara Valley Water District
Kristine Atkinson, California Department of Fish and Game
Steven Schoenberg, U.S. Fish and Wildlife Service

SUPPLEMENTAL BIOLOGICAL OPINION

AGENCY:	Department of the Army, Sacramento District Corps of Engineers
ACTION:	Flood Control Project for the Guadalupe River, Downtown San Jose, California
CONSULTATION CONDUCED BY:	National Marine Fisheries Service, Southwest Region
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I. CONSULTATION HISTORY

The Army Corps of Engineers (Corps) in cooperation with the Santa Clara Valley Water District (SCVWD) is currently constructing the Guadalupe River Project (Project) in downtown San Jose, California. The Project is designed to provide 100-year flood protection along 2.6 miles of the Guadalupe River. Formal consultation pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended, (16 U.S.C. 1531 *et seq.*) for the Project was completed by the Corps and the National Marine Fisheries Service (NOAA Fisheries) in the summer of 2000. NOAA Fisheries issued a biological opinion for the Project on August 11, 2000.

On May 11, 2001, the Corps reinitiated consultation on the Project to request modification of two terms and conditions contained in the incidental take statement attached to the August 11, 2000, biological opinion. Both terms and conditions, 1B and 1E, related to protection of aquatic organisms during in-water construction. NOAA Fisheries and Corps staff worked together to refine the construction-related aquatic species protection measures and determined that the two terms and conditions were not needed. On May 30, 2001, NOAA Fisheries amended the incidental take statement by eliminating terms and conditions 1B and 1E.

In coordination with the Project's Adaptive Management Team[1], NOAA Fisheries and the Corps worked together during the past 3 years to complete the Project's fisheries monitoring program. On July 16, 2002, the Corps requested reinitiation of formal consultation to address the Project's final fisheries monitoring plan. The monitoring methods were refined during 2002 and 2003 and a final project description was received by NOAA Fisheries in September of 2003.

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[1] The Adaptive Management Team is comprised of representatives from the Corps, SCVWD, NOAA Fisheries, California Department of Fish and Game, U.S. Fish and Wildlife Service, City of San Jose, San Francisco Bay Regional Water Quality Control Board, and the Guadalupe-Coyote Resource Conservation District.

This document transmits NOAA Fisheries' supplemental biological opinion based on our review of the July 15, 2002, document titled *Proposed Anadromous Fish Monitoring in the Guadalupe River Watershed and Related Potential Take of Steelhead* (Jones & Stokes 2002a). Additional information regarding the proposed fisheries monitoring plan was developed in coordination with the Project's Adaptive Management Team and is presented in the Project's *Water Year 2002 Final Mitigation and Monitoring Report* (Jones & Stokes 2002b). A complete administrative record of this consultation is on file at the NOAA Fisheries Santa Rosa office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Guadalupe River Project is currently under construction by the Corps and SCVWD along 2.6 miles of the Guadalupe River in downtown San Jose, California, from Interstate 880 (I-880) to Grant Street. The project has two offsite mitigation areas: Guadalupe River between Airport Parkway and I-880 and Guadalupe Creek between Almaden Expressway and Masson Dam. When the Project is completed in 2004, it will provide flood protection up to the design flow of 17,000 cfs to downtown San Jose and surrounding areas and mitigate adverse Project effects on anadromous fish and riparian habitat. A mitigation and monitoring plan (MMP) has been prepared for the Project which identifies the environmental mitigation and monitoring requirements (U.S. Army Corps of Engineers 2001a). Except for finalization and implementation of a ten year fisheries monitoring program, the Project's timing, design, scope, methods, and action area remain unchanged and are incorporated here by reference to the NOAA Fisheries' August 11, 2000, biological opinion.

The MMP identifies mitigation measures that will ensure the protection and restoration of environmental resources present in the Project area. The Corps and SCVWD will implement the MMP, including mitigation measures, monitoring commitments, and reporting commitments. The monitoring in the MMP is also intended to assist the Project's Adaptive Management Team in their effort to ensure the protection and restoration of environmental resources present in the Project area. The MMP includes the monitoring of several indicators of steelhead and Chinook salmon habitat conditions in the Guadalupe River. Physical environmental conditions that will be monitored include shaded stream surface, bank stability, instream cover, channel bottom stability, water temperature, spawning gravel abundance and quality, and rearing habitat diversity. In addition to monitoring the physical environmental conditions, the MMP includes monitoring for anadromous fish occurrence, including adult migration and spawning, and juvenile rearing.

A. Adult Salmonid Migration and Spawning

Adult salmonid migration and spawning will be monitored by surveys at approximately two-week intervals from October through mid-April annually for ten years. After ten years of surveys have been completed, the Project's Adaptive Management Team will determine the need for additional surveys. Experienced fish biologists will search the Guadalupe River throughout the Project area and the lower Guadalupe Creek mitigation area for likely steelhead and Chinook salmon spawning, redds, and carcasses. Visual observations will be recorded on maps or aerial photographs or entered into a geographic database. In addition, surveys will be performed on portions of the upper Guadalupe River, upper Guadalupe Creek, Alamitos Creek, Los Gatos Creek, and Calero Creek to document passage by adults through the Project area.

To evaluate Chinook salmon spawning success in the Project area and in a control reach (i.e. undisturbed by Project construction) of the Guadalupe River, three methods for assessing spawning conditions may be employed over the 10 year period. Proposed monitoring methods are measurements of gravel permeability, fry emergence trapping, and post-emergence redd excavation. Gravel permeability may be measured at different locations in the river with a portable stainless steel standpipe or at fixed locations using a buried PVC standpipe during the Chinook salmon spawning and incubation season (November through January). Based on methods developed by Terhune (1958), a stainless steel standpipe can be driven into the river bed to a depth of 8 to 14 inches and a water sample withdrawn from this area within the stream bed. Dissolved oxygen levels and water temperature can provide a measure of gravel permeability and survival rates for incubating salmonid eggs and larvae. Alternatively, gravel permeability can be measured in a fixed location using a buried PVC standpipe, and monitored over the course of a spawning season. Fry emergence trapping will involve the placement of a fine mesh net over the top of a Chinook salmon redd area at least 14 days before the calculated date of emergence. Chinook salmon redds will be identified during biweekly spawning ground surveys. Up to four redds per year may be selected for fry emergence trapping. The total number of Chinook salmon fry and total weight of fish collected in the emergence trap will be recorded twice daily. Redd excavation may also be used at locations identified as Chinook salmon spawning sites to determine the presence or absence of eggs or alevins. Redds will be excavated after the calculated date of emergence with a shovel and a large dip net immediately downstream. If viable eggs or alevins are found, excavations will immediately cease at that location. If non-viable eggs or alevins are found, excavations will continue until the entire redd area has been excavated.

B. Juvenile Salmonid Monitoring

Juvenile rearing will be monitored through a combination of electrofishing to determine relative fish abundance and densities, and collecting information on specific environmental conditions at the sampling locations. Data will be used to analyze relationships between habitat use and environmental conditions. Once a year for ten years during the fall months (September, October, or November), juvenile salmonids will be monitored in up to 20 stream sections: 12 sections in Reach A, Segments 1-3, and Woz Way to Park Avenue Bypass, and eight sections in Guadalupe Creek. Sampled stream sections will extended 100 to 150 feet and included at least two habitat types (i.e. pool, riffle, or run). Block nets will define the upstream and downstream limits of the sample sections. Multiple pass electrofishing will be used to collect all fish within the sample section of the stream. The entire sample section will be electrofished at least three times. The number of electrofishing passes may exceed three if necessary to achieve an adequate estimate of total steelhead abundance. Fish will be identified to species, salmonid life stage assessed (fry, parr, smolt), and fork length measured. If necessary to reduce stress associated with handling, fish will be anesthetized. Fish will be allowed to recover for a minimum of 15 minutes in a recovery tank before returning them to the stream at the location of collection. Environmental conditions at the site will be recorded including instream cover, habitat types, dominant substrate, shaded stream surface, and water temperature.

The juvenile rearing data will be used to assess the relationship between habitat use and specific environmental conditions. Appropriate parametric or nonparametric statistical methods will be applied to estimate juvenile steelhead densities in sample sections. Multiple years of data will be integrated to provide information of relative abundance, density, potential relationship to environmental conditions, and longitudinal distribution in the Guadalupe River watershed. Juvenile rearing will be monitored in these index reaches for a period of at least ten years after Project construction.

C. Reporting

Preliminary results of the juvenile electrofishing surveys will be reported to NOAA Fisheries within one week following completion of collection activities. If steelhead are encountered in any of the adult salmonid spawning and migration surveys, results will also be reported to NOAA Fisheries within one week of the observation. Annual reporting of all study results will be prepared for each monitoring activity and presented no later than March 31 of each year in the annual Mitigation and Monitoring Report (MMR) by the Corps and SCVWD.

III. DESCRIPTION AND STATUS OF THE SPECIES

This reinitiation will affect threatened Central California Coast steelhead (62 FR 43937; August 18, 1997). Species description, including life history, status, trend and likelihood of survival and recovery is detailed in NOAA Fisheries August 11, 2000, biological opinion for the Project and is hereby incorporated by reference.

Although there is no historical account of Chinook salmon migrating and spawning in the Guadalupe River, fall-run Chinook salmon (*Oncorhynchus tshawytscha*) have occurred in the Guadalupe River watershed during the past decade (U.S. Army Corps of Engineers 2001b). The results of genetic analyses of these Chinook salmon to determine their origin has been inconclusive, but some genetic material is consistent with populations from the Sacramento-San Joaquin River system (Nielson, 1995) including Merced and Feather River hatcheries (NOAA Fisheries 1999). Additional information on genetic and life history traits of Guadalupe River Chinook salmon and their relationships with Central Valley and coastal Chinook salmon populations are necessary to confirm their affinity with a West Coast Chinook salmon

Evolutionary Significant Unit. At present, Chinook salmon that occur in the Guadalupe River are not listed under the ESA.

IV. ENVIRONMENTAL BASELINE

In the three years since the issuance of the August 11, 2000, biological opinion, the status of CCC steelhead in the action area has not substantially changed. However, baseline conditions for the action area have changed in both the Guadalupe River and in the Guadalupe Creek mitigation reach. Construction of portions of the flood project in the 2.6 mile reach of the Guadalupe River has resulted in more areas of hardened stream bank and armored channel bed sections. Newly armored bed sections extend approximately 850 feet in Segment 3A, 1,850 feet in Segment 3B, and 1,250 feet in Segment 3C. A trapezoidal low flow channel with an approximate flow capacity of 35 cfs winds through these armored channel reaches. Some riparian vegetation has been permanently lost in these areas, although new plantings are rapidly growing along some banks to provide future stream shading. The fish passage barrier at the Saint John Street weir has been partly removed and upstream passage for adult salmonids is expected to be better during the winter of 2003-04. Complete removal of the Saint John Street weir structure is scheduled for summer 2004. An exposed gas and sewer line in Segment 3A that may have impeded fish passage has been relocated underground. Two underground flood bypasses have been completed to pass high flows in the Guadalupe River. The upper bypass begins at the downstream end of Segment 3C and returns flows to the river at Segment 3B. The lower bypass is still under construction and it begins at the downstream end of Segment 3B and returns flows to the river at downstream end of the Project. These reaches of the Guadalupe River are primarily migration corridors for upstream migrating adult steelhead and downstream migrating smolts. The expected effects of the flood project construction and operation are described in the August 11, 2000, biological opinion. With the creation of a constructed low flow channel in armored reaches and removal of several pre-existing impediments to fish passage, the Project has improved conditions for steelhead passage in the action area.

Approximately 7 miles upstream of the Guadalupe River project area, the Corps and SCVWD completed in 2001 and 2002 the Guadalupe Creek Restoration Project. This restoration project on a major tributary to Guadalupe River is independent of the flood control project and provides a suitable area for mitigation for a variety of actions in the Guadalupe River watershed. The Project used a portion of the Guadalupe Creek Restoration Project to mitigate for loss of shaded riverine aquatic (SRA) cover vegetation and habitat impacts associated with construction of flood control facilities on the Guadalupe River. Along a 5,971-foot long reach of Guadalupe Creek, the Corps and SCVWD restored an area that was characterized by sparse and fragmented riparian vegetation, steep banks, and incised stream channel. Restoration of the site included modification of the channel configuration to increase in-stream habitat diversity and complexity. Stream banks were graded to increase floodplain area. Rootwads, large wood material, and wood/boulder complexes were installed along the banks of the low flow channel. Riparian vegetation was planted within a 15-foot buffer strip of the summer low flow channel. To date, the project appears to have successfully transformed a degraded incised reach of an urban stream into a broader, meandering channel with the beginnings of SRA cover. This restored reach of Guadalupe Creek is expected to provide significant benefits to both rearing and spawning habitat values for steelhead and Chinook salmon.

V. EFFECTS OF THE ACTION

The purpose of this section is to identify the effects to CCC steelhead resulting from the fisheries monitoring program of the Project. The other effects of the project, as described in the original opinion, remain unchanged, and NOAA Fisheries' observation of current conditions indicates effects to date are as expected. A detailed description of these physical, chemical and biotic effects threatened CCC steelhead was provided in the August 11, 2000, biological opinion and is incorporated here by reference.

A. Adult Salmonid Spawning and Migration

Visual surveys by experienced fish biologists during the period from October through mid-April are expected to disturb some steelhead that are spawning, or holding in the Guadalupe River and its tributaries. Surveyors wading in the stream or walking on the bank are likely to be detected by steelhead and cause adult fish to immediately seek cover. Startled fish will likely swim at burst speed to an area for hiding until the perceived threat has disappeared. In-stream hiding places for adult salmonids are typically areas with cover provided by water depth, water turbulence, vegetation, large organic debris, or undercut banks. Upon completion of any site measurements or recording of observations, surveyors will leave the site and adult fish are expected to return to their pre-startled location and activities within a few minutes. No adverse effects are expected to occur associated with the temporary disturbance of adult steelhead during spawning ground surveys. Experienced fish biologists are also likely to exercise care to avoid walking on or otherwise disturbing areas with freshly deposited eggs or alevins. Thus, no damage to steelhead eggs or alevins is expected.

Proposed monitoring of Chinook salmon spawning success involves gravel permeability measurements, fry emergence trapping, and redd excavation. These monitoring techniques will only be used during the Chinook salmon spawning and incubation season between October and January. The sampling sites will also be limited to areas where Chinook salmon spawning was observed earlier in the same season. Thus, these monitoring activities are not expected to occur in areas where steelhead have spawned and will have minimal overlap with the steelhead spawning season. Steelhead spawning primarily occurs in upstream tributary areas of the Guadalupe River watershed and occurs during the period between January and March. Due to the differences in spawning location and timing, steelhead eggs and alevins are not expected to be present at the sampling sites for evaluation of Chinook salmon spawning success. Proposed monitoring of Chinook salmon spawning conditions is not expected to adversely affect steelhead.

B. Juvenile Salmonid Monitoring

Juvenile steelhead will be collected by annual electrofishing surveys of index reaches in the Guadalupe River and Guadalupe Creek. Experienced fish biologists will conduct this monitoring based on current standards of care for fish collection, transport, and release. Surveys will be performed during the fall months when water temperatures are cooler and steelhead young-of-year have completed approximately 3-6 months of summer growth.

Any fish collecting gear, whether passive (Hubert 1983) or active (Hayes 1983) has some associated risk to the fish, including stress, disease transmission, injury, or death. Electrofishing is of particular concern. Electrofishing can kill both juvenile and adult fish, and researchers have found serious sublethal effects including spinal injuries (Reynolds 1983, Zeigenfuss 1995, Habera et al. 1996, Nielsen 1998, Habera et al. 1999, Nordwall 1999, Sharber and Carothers 1988). Estimates of non-lethal spinal and hemorrhagic injury rates resulting from electrofishing range from zero to 23 percent (Hollender and Carline 1994, Habera *et al.* 1996, Kocovsky *et al.* 1997). An average five-percent injury rate has been suggested for steelhead in tributaries of the Yakima River in Washington (McMichael *et al.* 1998). The injury rate for juvenile steelhead collected during monitoring of these index reaches is likely to be low, because smaller fish (250 mm or less in length) have less risk of injury from electrofishing than do larger adult fish (Hollender and Carline 1994, Dalby *et al.* 1996, McMichael *et al.* 1998).

Based on the results of past electrofishing surveys in the Guadalupe River, few to no steelhead are likely to be found at the 12 Guadalupe River sampling sites (RGW Construction 2001, Cressy 2002). In Guadalupe Creek, Li (2000) found a correlation between water temperature and young-of-year steelhead abundance with fewer fish in the downstream areas of warmer temperatures. Therefore, of the eight Guadalupe Creek sampling sites, the four locations upstream of Masson Dam are expected to contain higher densities of steelhead juveniles than the four sites downstream of Masson Dam. Li (2000) also reported young-of-year steelhead densities in Guadalupe Creek during August 2000 as approximately 38 fish per 100 feet in pools and 30 fish per 100 feet in riffles. Juvenile steelhead densities in Guadalupe Creek ranged from 18 fish per 100 feet in pools and ten fish per 100 feet in riffles (Li 2000). If similar densities occur during this Project's electrofishing surveys, from 240 to 456 young-of-year steelhead and 80 to 216 juvenile steelhead may be collected annually during sampling of 800 to 1,200 feet of stream (i.e. index reaches). After processing and recovery in an isolated tank, steelhead will be returned to the stream into the habitats from where they were collected. Based on the current standards of care for electrofish collection, transport, and release, rates of steelhead injury and mortality is not expected to exceed five percent.

VI. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation". Future Federal actions will be reviewed through separate section 7 consultation processes and not considered here. Non-Federal actions that require authorization under section 10 of the ESA will be evaluated in separate section 7 consultations and not considered here.

Similar to the environmental baseline, NOAA Fisheries has determined that cumulative effects in and near the action area have not changed in any appreciable way since the issuance of the August 11, 2000, biological opinion. Therefore that opinion's review of cumulative effects is incorporated here by reference.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

This supplemental biological opinion evaluates the effects of the Project's fisheries monitoring program on CCC steelhead. The effects analysis considers the population status of CCC steelhead, the existing environmental baseline conditions within the affected area, and the effects of the continuation of the entire Project on the likelihood of survival and recovery of CCC steelhead. CCC steelhead are at a moderate risk of extinction. They have experienced population declines and habitat degradation continues throughout the ESU. However, they have maintained a wide distribution and have experienced little fragmentation.

Habitat conditions within the action area are generally poor. Summer rearing habitat in the mainstem of the Guadalupe River is marginal due to elevated stream temperatures and the presence of warm-water predator fish species. Overwinter and outmigration habitat conditions are also poor because the mainstem channel lacks habitat complexity and velocity refuge. Factors contributing to these habitat conditions include flood control, water development, past agricultural practices, and a variety of other activities associated with urban and rural developments within the watershed. The impoundment and regulated discharge of reservoirs on Guadalupe River tributaries affect the transport of sediment and the ability of flows to form channel features. Degraded habitat conditions and channel incision has greatly reduced habitat complexity in the action area.

CCC steelhead are seasonally present in the action area. Adult steelhead migrate through the Guadalupe River during the winter months to access upstream spawning areas and juveniles outmigrate during the late winter and spring as smolts to access San Francisco Bay and the ocean. In the past spawning has not been observed in the action area, but restoration of lower Guadalupe Creek has improved spawning habitat suitability and may encourage future spawning by steelhead in this area. The Guadalupe River portion of the action area provides marginal rearing habitat, but habitat restoration completed in 2002 in Guadalupe Creek will likely provided suitable rearing conditions for juvenile steelhead in the near future.

The proposed fisheries monitoring program is expected to contribute new and valuable information regarding habitat conditions, fish distribution, and fish abundance in the Guadalupe River watershed. Adult spawning and migration monitoring will provide information regarding the timing, distribution, migration barriers, and relative abundance of adult salmonid spawners in the watershed. This information will assist in the management of streamflows, water temperatures, and other activities that effect water quality and aquatic habitats in the watershed. Spawning ground survey results can be used to prioritize actions and mitigation measures in a manner to optimize spawning and incubation conditions for anadromous salmonids. The juvenile salmonid monitoring program will provide an annual index of juvenile steelhead abundance by stream reach. This abundance information can be used to assess relationships between environmental conditions, management actions, and steelhead occurrence. As with the adult spawner survey results, this information regarding juvenile salmonids will be valuable for managing streamflows, water temperatures, and other activities that effect water quality and aquatic habitats in the watershed.

While some take of listed CCC steelhead juveniles will occur, it is not expected to rise to a level where it will appreciably reduce the numbers, distribution, or reproduction of CCC steelhead populations in the Guadalupe River Watershed. NOAA Fisheries expects the basin's salmonid populations to be resilient to these small potential losses because: 1) habitat conditions for salmonid migration, spawning, and rearing have been improved in the action area, likely resulting in increasing juvenile production, and 2) the duration and timing of sampling will expose few members of the juvenile population in the Guadalupe River watershed to harmful effects during the ten year sampling period. The likelihood of survival and recovery of this population is therefore not expected to be appreciably reduced. By extension then, the survival and recovery of CCC steelhead at the ESU level is not likely to be appreciably reduced.

VIII. CONCLUSION

After reviewing the best available scientific and commercial data regarding the current status of the threatened CCC steelhead and the current condition of the environmental baseline in the action area, and cumulative effects, it is NOAA Fisheries' biological opinion that the proposed fisheries monitoring program of the Guadalupe River Project is not likely to jeopardize the continued existence of threatened CCC steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NOAA Fisheries further defines "harm" as an act that actually kills or injures a protected species (64 FR 60727). Harm can arise from significant habitat modification or degradation where it actually kills or injures protected species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps and the SCVWD for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require SCVWD to adhere to the terms and conditions of the incidental take statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and SCVWD must report the progress of the action and its impact on the species to NOAA Fisheries as specified in the incidental take statement (51 FR 19926).

For the sake of clarity, the incidental take statement attached to the August 11, 2000, biological opinion and as amended on May 30, 2001, is presented below in its entirety. Additions to the incidental take statement associated with this supplemental biological opinion for the fisheries monitoring program are noted as "new text".

A. Amount or Extent of Take

NOAA Fisheries anticipates incidental take of steelhead will be difficult to detect due to the dimensions and variability of the Guadalupe River system and the operational complexities of the phased flood control construction activities. However, the instream and riparian habitat of the steelhead will be both temporarily and permanently modified by the proposed action. This modification is expected to result in the harm, harassment, and mortality of juvenile and adult steelhead by changing water temperatures, prey availability and reducing available spawning habitat. Therefore, the level of take of this species is measured by the temporary loss of an estimated 7.6 acres of riparian vegetation, 4,634 linear feet of shaded riverine aquatic cover habitat, and 20,500 square feet of spawning gravel habitat. These losses adversely affect adult steelhead spawning and juvenile steelhead rearing and foraging opportunities, and may result in reduced survival. In addition, some fish may be stranded during construction (and relocated). NOAA Fisheries believes that stranding will be a rare event that will affect a few fish, probably less than 10 per construction season. If stranded fish are relocated, it is likely that most will survive the relocation, thereby minimizing impacts to the population. NOAA Fisheries anticipates that no more than 10 percent of the relocated fish may die as a result of capture and handling methods/effects. Take is not expected to occur from bypass channel operations.

New text: Monitoring of the Juvenile Rearing Indicator for Steelhead by the fisheries monitoring program will sampled from 800 to 1,200 linear feet of stream annually by electrofishing. Based on fish densities in past electrofishing surveys in the watershed, NOAA Fisheries expects the juvenile salmonid monitoring program will collect 240 to 456 young-of-year steelhead (age 0+) and 80 to 216 juvenile steelhead (age 1+) during the annual sampling of index reaches. Based on the current standards of care for electrofish collection, transport, and release, rates of steelhead injury and mortality are not expected to exceed five percent.

B. Effect of the Take

In the accompanying biological opinion, NOAA Fisheries determined that this level of anticipated take is not likely to result in jeopardy to the CCC steelhead ESU.

C. Reasonable and Prudent Measures

NOAA Fisheries believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of threatened CCC steelhead caused by activities related to the Guadalupe River Project:

1. Avoid and minimize bank and instream construction impacts to the Guadalupe River ecosystem.

2. Minimize the extent of temporary and permanent changes to instream and riparian habitat and ensure that proposed mitigation measures used to replace these losses meet identified measurable objectives (U.S. Army Corps of Engineers and Santa Clara Valley Water District 2000).

3. Use a fisheries biologist for the purposes of monitoring the affected area, and for removing and relocating steelhead from the affected area.

4. Implement adequate control measures to avoid or minimize sediment, turbidity and pollutant inputs to the Guadalupe River.

5. Prepare and submit monitoring reports annually to document status of construction as well as mitigation activities and performance.

6. **New text:** Measures shall be taken to minimize adverse effects to CCC steelhead associated with implementation of the fisheries monitoring program and monitoring results shall be reported annually to ensure the program is providing information useful to managing the operation and maintenance of the Project.

D. Terms and Conditions

The Corps is responsible for the following Terms and Conditions that implement the reasonable and prudent measures described above. These Terms and Conditions are intended to minimize incidental take of steelhead associated with the Guadalupe River Flood Control Project.

1. The following Terms and Conditions implement Reasonable and Prudent Measure No. 1.

   A. The Corps and SCVWD shall isolate each workspace from flowing water for the purpose of avoiding heavy equipment in flowing water, sedimentation, turbidity, and direct effects to steelhead. Prior to construction activities, diversion materials shall be installed (e.g., sandbag cofferdams, straw bales) to divert steamflow away or around each workspace. The diversion shall remain in place during the project construction, then removed immediately after work is completed.

   B. ~~The Corps and SCVWD shall ensure and maintain a corridor for unimpeded passage of steelhead during construction of the project action.~~ **Eliminated by May 30, 2001, amendment.**

   C. When practical, the Corps and SCVWD shall use existing points of ingress or egress, or perform work from the top of the river bank, for the purpose of avoiding work and heavy equipment in flowing water, and disturbing riverbank, vegetation, and instream habitat.

   D. The Corps and SCVWD shall confine in-channel construction activities to the summer low-precipitation period (April 15 - October 15), with the condition that construction requiring stream dewatering, stream crossing or work in the channel invert not commence until May 1, assuming that two stream-monitoring criteria are met. The first is that a qualified fisheries biologist (see Term and Condition No. 3A) survey the project area and verify the absence of juvenile steelhead for a minimum of three consecutive sampling days. The second is that average daily water temperatures exceed 68°F for a minimum of three consecutive days. Should stream-monitoring criteria not be met, channel invert work and stream dewatering will not be allowed until June 1.

   E. ~~All aquatic macrofauna that may be affected by instream activities shall be removed from the work site by a qualified fisheries biologist (see Term and Condition No. 3B) and placed downstream.~~ **Eliminated by May 30, 2001, amendment.**

   G. The Corps and SCVWD shall examine all opportunities for reducing the amount of hardscape bank and river bottom armoring (e.g., New Julian Bridge, Coleman Avenue Bridge, bypass system inlet structures) whenever possible.

   H. The Corps and SCVWD shall design a low flow channel and bypass channel outlets for both the Santa Clara Street-Coleman Avenue bypass and the Woz Way-Park Avenue bypass protective to steelhead and approved by NOAA

Fisheries.

I. A worker education program shall be conducted prior to construction activities on the importance of protecting steelhead and their critical habitat and the project measures to do so.

2. The following Terms and Conditions implement Reasonable and Prudent Measure No. 2.

A. The Corps and SCVWD shall photograph the project area prior to and after each construction season for the purpose of developing a reference library of instream and riparian habitat characteristics.

B. The Corps and SCVWD shall prepare and implement a Mitigation and Monitoring Plan to address the replacement and re-establishment of riparian vegetation (including SRA cover) and instream habitat functions. The plan will also describe maintenance procedures to protect and enhance the riparian system. The Mitigation and Monitoring Plan shall include offsite SRA mitigation that could expand the existing range of steelhead in the watershed. The plan shall be submitted to NOAA Fisheries for review and approval before initiating construction. NOAA Fisheries shall provide in writing either concurrence with the plan or notification to the Corps and SCVWD that plan modifications are necessary for acceptance.

C. The Corps and SCVWD shall incorporate an adaptive management process to insure that monitored indicators of measurable objectives are fully met and, if necessary, appropriate remedial actions are taken to ensure that agreed upon ecological functions and habitat values defined in the Mitigation and Monitoring Plan and affected by the Project are reestablished and maintained.

D. All mitigation areas that have been set aside as compensation for project impacts resulting from this project or any other project will not be disturbed or impacted during construction activities and will be preserved in perpetuity and not used as mitigation for other projects.

E. The Corps and SCVWD shall prepare and implement a Vegetation Protection Plan to prevent the inadvertent loss of riparian vegetation above and beyond that necessarily resulting for project construction activities. The plan will also describe remedial actions required if preserved trees are inadvertently impacted by construction activities. The plan shall be submitted to NOAA Fisheries for review and approval before initiating construction. NOAA Fisheries shall provide in writing either concurrence with the plan or notification to the Corps and SCVWD that plan modifications are necessary for acceptance.

3. The following Terms and Conditions implement Reasonable and Prudent Measure No. 3.

   A. The Corps and SCVWD shall retain a fisheries biologist with expertise in the areas of resident or anadromous salmonid biology and ecology, fish/habitat relationships, and biological monitoring; and handling, collecting, and relocating salmonid species. The biologist will monitor activities prior to and during inchannel activities especially during temporary blockage or redirection of the flow of water through the use of coffer dams or culverts.

   B. The biologist shall monitor placement and removal of channel diversions for the purpose of removing any steelhead that would be adversely affected. The biologist shall capture such steelhead and individuals stranded in residual wetted areas as a result of streamflow diversion and workspace dewatering, and relocate the individuals to a suitable location immediately upstream or downstream of the particular project area. One or more of the following NOAA Fisheries approved methods shall be used to capture steelhead: dip net, seine, throw net, minnow trap, and hand. Electrofishing may only be used if NOAA Fisheries has reviewed the biologist's qualifications and given approval. The biologist shall note the number of individual steelhead observed in the affected area, the number of individuals relocated, and the date and time of the collection and relocation.

   C. The biologist shall monitor inchannel activities, instream habitat, and performance of sediment control/detention devices (see Term and Condition No. 4) for the purpose of identifying and reconciling any condition that could adversely affect steelhead or their habitat. The Corps and SCVWD and their contractors, upon notification for the biologist, shall halt the work activity causing the condition affecting steelhead and recommend measures for avoiding the condition. Work can resume when NOAA Fisheries agrees that the proposed measures are appropriate for avoiding the condition.

   D. The biologist shall contact NOAA Fisheries (707-575-6050) immediately if one or more steelhead are found dead or injured. The purpose of the contact shall be to review the activities resulting in take and to determine if additional protective measures are required,

4. The following Terms and Conditions implement Reasonable and Prudent Measure No. 4.

   A. Erosion control and sediment detention devices shall be incorporated into the project and implemented at the time of the project action. These devices shall be in place during the project action, and after if necessary, for the purpose of minimizing fine sediment and sediment/water slurry input to flowing water. The devices shall be placed at all locations where the likelihood of sediment input exists.

B. At the time of the project action, the Corps and SCVWD shall prepare and implement a Storm Water Pollution Prevention Plan as part of the National Pollutant Discharge Elimination System (NPDES) to avoid or minimize increased sediment and turbidity impacts. This plan will be reviewed and approved by NOAA Fisheries prior to construction.

C. The Corps and SCVWD shall prepare and implement an Erosion and Sediment Control Plan for minimizing the potential for sediment input into the stream, a Toxic Material Control and Spill Response Plan for preventing toxic material spills, a Soil Management Plan that provides criteria for classifying wastes in soil and managing soils possibly contaminated with mercury and methyl mercury concentrations and a Hazardous and Toxic Materials Contingency Plan in the event that unlisted hazardous materials and toxic sites are uncovered during construction.

D. The Corps and SCVWD shall fully cooperate with State and Federal agencies involved with mercury contamination issues to insure that actions involving the flood control project including mitigation issues are compatible and conducted in a cooperative manner with potential mercury contamination cleanup actions.

E. All water within the construction site shall be pumped off-site or into a settling basin or tank and not directly into the downstream channel.

F. All pilings, support piers, abutments and rock materials shall be non-toxic. Any combination of wood, plastic, concrete, or steel is acceptable, provided that there are no toxic coatings, chemical antifouling products, or other treatments that may leach into the surrounding environment.

5. The following Terms and Conditions implement Reasonable and Prudent Measure No. 5.

A. The Corps and SCVWD shall provide a written construction monitoring report to NOAA Fisheries within 30 working days following completion of each construction season (no later than November 30). The report shall include the number of steelhead killed or injured during the project action and biological monitoring; the number and size of steelhead; any effect of the project action on steelhead that was not previously considered (reinitiation of consultation would be required, see section IX, item 2 of the Biological Opinion); photographs documenting compliance with Reasonable and Prudent Measures No. 1, 2 and 4; and, photographs taken before and after work activity.

B. The Corps and SCVWD shall provide a written report describing results of their mitigation activities to NOAA Fisheries on a schedule that is developed in the Mitigation and Monitoring Plan. At the very minimum, the report shall include a description of the locations planted or seeded, the area (ft^2) revegetated, a plant palette, planting or seeding methods, performance or success criteria, and pre- and post-planting color photographs of the revegetated area.

C. The Corps and SCVWD shall provide a written report describing results of their vegetation Protection Plan to NOAA Fisheries on a schedule that is developed during the adoption of the plan.

D. All reports, proposed plans, and annual updates shall be submitted to: Protected Resources Division Supervisor, NOAA Fisheries, Santa Rosa Area Office, 777 Sonoma Avenue, Room 325, Santa Rosa, California; (707) 575-6050; Fax (707) 578-3435.

6. **New text:** The following Terms and Conditions implement Reasonable and Prudent Measure No. 6.

A. **New text:** All results and associated analyses from the fisheries monitoring program shall be reported annually to NOAA Fisheries in the Project's Mitigation and Monitoring Report. In addition, a preliminary report of the results of monitoring adult salmonid migration and spawning and juvenile rearing for Steelhead shall be provided to NOAA Fisheries within five months of the last field survey date for each indicator. The early submittal of the preliminary results will allow NOAA Fisheries to review the results and to recommend improvements to the survey methods prior to commencement of the subsequent year's monitoring (see Term and Condition 5D for reporting).

B. **New text:** NOAA Fisheries staff shall be provided access to observe all fisheries monitoring program activities.

C. **New text:** A qualified fisheries biologist shall be on site during all electrofishing for rearing juvenile steelhead. The biologist shall ensure that the proper number of trained individuals are present to conduct fish sampling in a timely and safe manner at the site. Methods for sampling fish shall be those that minimize impact to salmonids. Electrofishing shall be conducted in accordance with the following guidelines:

1. When electrofishing for rearing juvenile steelhead, block nets shall be set up at the upstream and downstream extent of each sampled reach to prevent immigration and emigration of salmonids during sampling activities.

2. Electrofishing efforts should start with voltage, pulse width, and pulse rate set at or near the minimum values needed to capture fish. Settings should

gradually be increased only to the point where fish are immobilized for capture.

3. Individuals that are netting immobilized fish should remove fish immediately from the water, and not allow the fish to remain in the electrical field for an extended period of time.

4. Water temperature in the stream and in containers holding captured fish should not exceed 18°C at any time during the sampling effort.

5. Captured fish should be released to appropriate stream areas as soon as possible.

D. **New text:** If mortality of juvenile steelhead during electrofishing surveys exceeds five percent of the total number of steelhead captured at any single sampling location or cumulatively, NOAA Fisheries must be notified within 24 hours (see Term and Condition 5D for reporting).

X. CONSERVATION RECOMMENDATIONS

All conservation recommendations described in the August 11, 2000, biological opinion still apply to the supplemental biological opinion and are incorporated here by reference.

XI. REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the project proposal. In addition to the reinitiation events noted above, reinitiation of formal consultation is required where discretionary Federal involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in this opinion; (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action (50 CFR 402.16). In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. LITERATURE CITED

Cressy, S. 2002. Fish salvage report, Guadalupe River near Woz Way, June 2002. June 13, 2002.

Dalby, S.R., T.E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury on long-term growth and survival of wild rainbow trout. North American J. of Fisheries Management. 16: 560-569.

Habera, J.W. R.J. Strange, B.D. Carter, and S.E. Moore. 1996. Short-term mortality and injury caused by three-pass electrofishing in a Southern Appalachian stream. North American J. of Fisheries Management 16:192-200.

Habera, J.W. R.J. Strange, and A.M. Saxton. 1999. AC electrofishing injury of large brown trout in low-conductivity streams. North American J. of Fisheries Management 19:120-126.

Hayes, M.L. 1983. Active Capture Techniques. Pages 123-146 in L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland. 468 pages.

Hollender, B.A., and R.F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American J. of Fisheries Management 14:643-649.

Hubert, W.A. 1983. Passive Capture Techniques. Pages 95-122 in L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland. 468 pages.

Jones & Stokes. 2002a. Proposed anadromous fish monitoring in the Guadalupe River watershed and related potential take of steelhead. July 15, 2002. Sacramento, CA. Prepared for the U.S. Army Corps of Engineers, Sacramento District, California.

Jones & Stokes. 2002b. Water year 2002 mitigation monitoring report for the Guadalupe River Project, downtown San Jose, California. Final. August 2002. Sacramento, CA. Prepared for the U.S. Army Corps of Engineers, Sacramento District, California, in coordination with the Santa Clara Valley Water District, San Jose, CA.

Kocovsky, P.M., C. Gowan, K.D. Fausch, and S.C. Riley. 1997. Spinal injury rates in three wild trout populations in Colorado after eight years of backpack electrofishing. North American J. of Fisheries Management 17:308-313.

Li, S. 2001. Draft Electrofishing Surveys on Guadalupe, Stevens, Coyote and Penitentia creeks: Catch Results. Aquatic Systems Research. Loomis, California.

McMichael, G.A., A.L. Fritts, and T.N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach and stream scales. North American Journal of Fisheries Management. 18:894-904.

Nielson, J.L. 1995. Salmon from the Sacramento-San Joaquin Basin and Guadalupe River, 1992-94. Unpublished report. Hopkins Marine Station, Department of Biology, Stanford University. Palo Alto, CA.

Nielsen, J.L. 1998. Electrofishing California's endangered fish populations. Fisheries 23:6-12.

NOAA Fisheries. 1999. Status review update for four deferred ESUs of Chinook salmon: Central Valley Spring Run, Central Valley Fall and Late-Fall Run, South Oregon and California Coastal, and Snake River Fall Run. August 9, 1999.

Nordwall, F. 1999. Movements of brown trout in a small stream: effects of electrofishing and consequences for population estimates. North American Journal of Fisheries Management 19:462-469.

Reynolds, J.B. 1983. Electrofishing. Pages 147-164 in L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland. 468 pages.

RGW Construction, Inc. 2001. Annual construction monitoring report. Guadalupe River, contract 3C, Phase 2, San Jose, Santa Clara County, CA. DACW05-01-C-0007. November 12, 2001.

Sharber, N.G., and S.W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Terhune, L.D.B. 1958. The Mark VI groundwater standpipe for measuring seepage through salmon spawning gravel. Journal of the Fisheries Research Board of Canada, 15(5): 1027-1063.

U.S. Army Corps of Engineers. 2001a. Guadalupe River project, downtown San Jose, California, mitigation and monitoring plan. February 2001 Sacramento, California. Prepared by Jones & Stokes, Sacramento, CA.

U.S. Army Corps of Engineers. 2001b. Final general re-evaluation & environmental report for proposed project modifications, Guadalupe River project, downtown San Jose, California. Vol. 1, February 2001.

Zeigenfuss, L.F. 1995. The effects of electrofishing and electrofishing induced injuries on the return and growth of rainbow trout. Master of Science Thesis. Colorado State University.

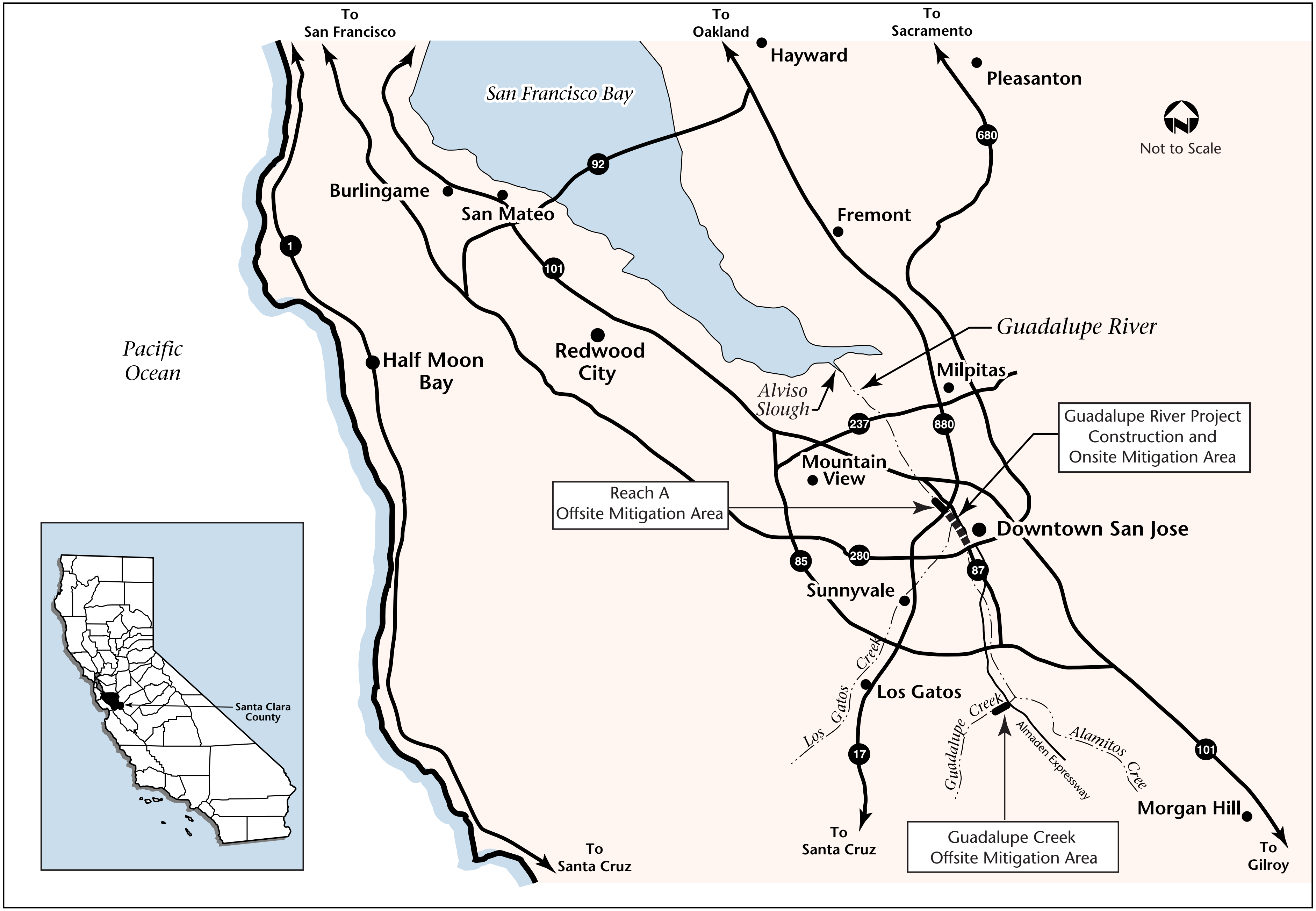

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Figure 1-1
Guadalupe River Project Vicinity Map

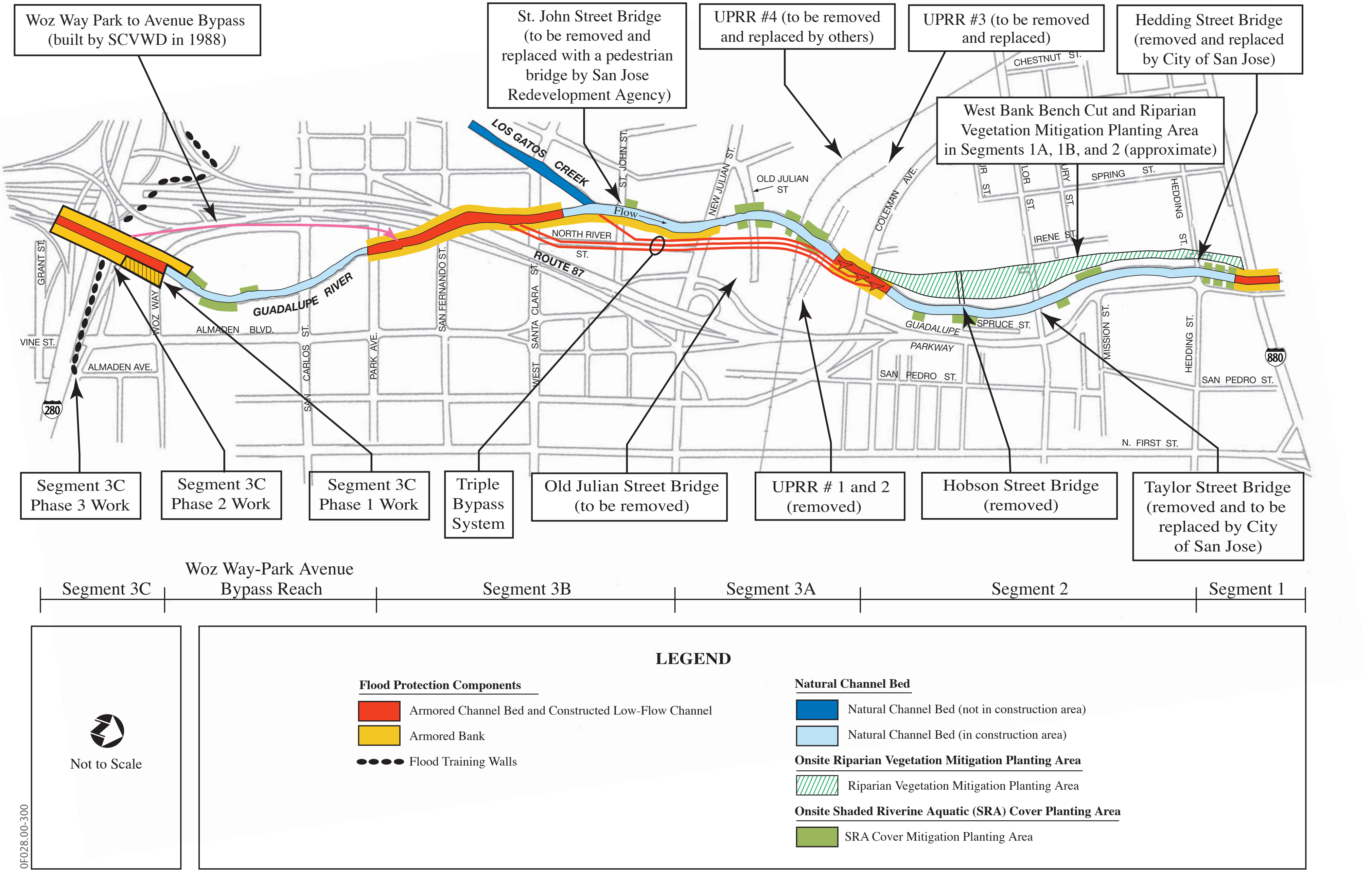
Woz Way Park to Avenue Bypass (built by SCVWD in 1988)
St. John Street Bridge (to be removed and replaced with a pedestrian bridge by San Jose Redevelopment Agency)
UPRR #4 (to be removed and replaced by others)
UPRR #3 (to be removed and replaced)
Hedding Street Bridge (removed and replaced by City of San Jose)
West Bank Bench Cut and Riparian Vegetation Mitigation Planting Area in Segments 1A, 1B, and 2 (approximate)
Segment 3C Phase 3 Work
Segment 3C Phase 2 Work
Segment 3C Phase 1 Work
Triple Bypass System
Old Julian Street Bridge (to be removed)
UPRR # 1 and 2 (removed)
Hobson Street Bridge (removed)
Taylor Street Bridge (removed and to be replaced by City of San Jose)
LOS GATOS CREEK
GUADALUPE RIVER
Flow
ROUTE 87
NORTH RIVER ST.
ST. JOHN ST.
NEW JULIAN ST.
OLD JULIAN ST
COLEMAN AVE.
CHESTNUT ST.
SPRING ST.
IRENE ST.
HEDDING ST.
GUADALUPE PARKWAY
SPRUCE ST.
MISSION ST.
SAN PEDRO ST.
N. FIRST ST.
880
GRANT ST.
VINE ST.
ALMADEN AVE.
ALMADEN BLVD.
WOZ WAY
SAN CARLOS ST.
PARK AVE.
SAN FERNANDO ST.
WEST SANTA CLARA ST.
280
Segment 3C
Woz Way-Park Avenue Bypass Reach
Segment 3B
Segment 3A
Segment 2
Segment 1
Not to Scale
0F028.00-300
LEGEND
Flood Protection Components
Armored Channel Bed and Constructed Low-Flow Channel
Armored Bank
Flood Training Walls
Natural Channel Bed
Natural Channel Bed (not in construction area)
Natural Channel Bed (in construction area)
Onsite Riparian Vegetation Mitigation Planting Area
Riparian Vegetation Mitigation Planting Area
Onsite Shaded Riverine Aquatic (SRA) Cover Planting Area
SRA Cover Mitigation Planting Area

Figure 1-2
Segments 1, 2, 3A, 3B, and 3C, and Woz Way to Park Avenue Bypass

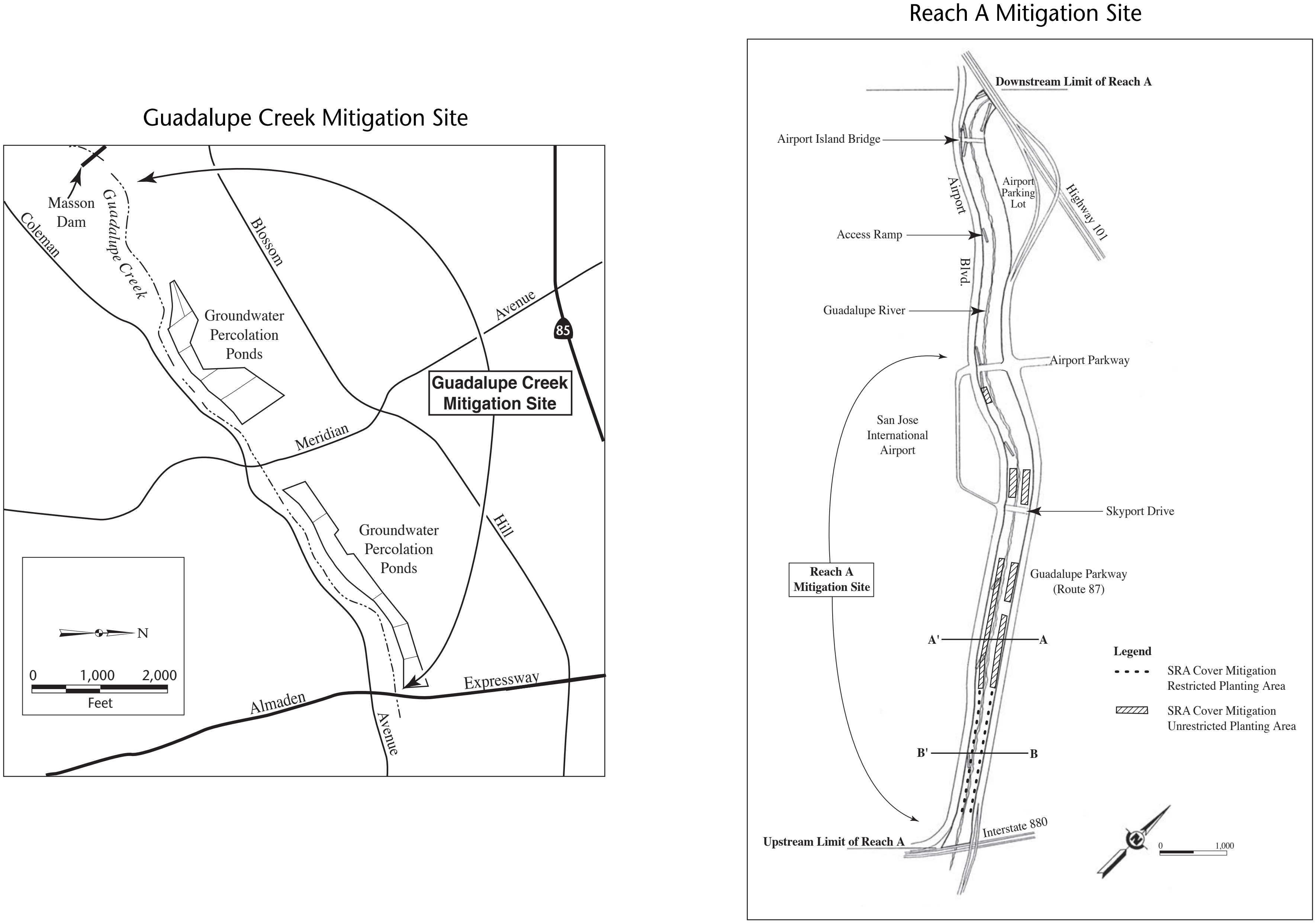
Guadalupe Creek Mitigation Site
Masson Dam
Coleman
Guadalupe Creek
Blossom
Groundwater Percolation Ponds
Avenue
85
Guadalupe Creek Mitigation Site
Meridian
Hill
Groundwater Percolation Ponds
N
0
1,000
2,000
Feet
Almaden
Expressway
Avenue
Reach A Mitigation Site
Downstream Limit of Reach A
Airport Island Bridge
Airport
Airport Parking Lot
Highway 101
Access Ramp
Blvd.
Guadalupe River
Airport Parkway
San Jose International Airport
Skyport Drive
Reach A Mitigation Site
Guadalupe Parkway (Route 87)
A'
A
Legend
SRA Cover Mitigation Restricted Planting Area
SRA Cover Mitigation Unrestricted Planting Area
B'
B
Interstate 880
Upstream Limit of Reach A
0
1,000

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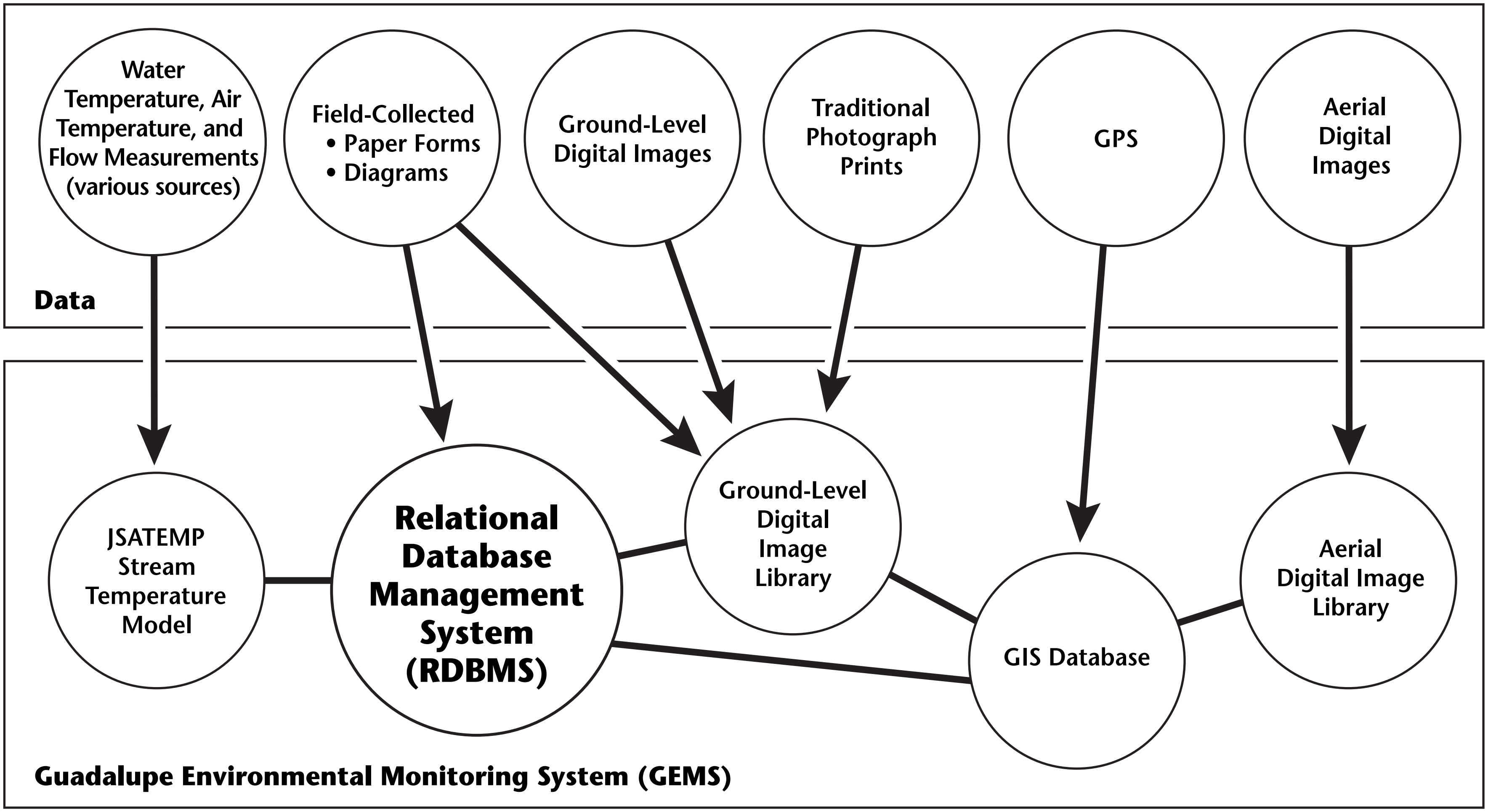
Figure 1-3
Offsite Mitigation Areas


Water Temperature, Air Temperature, and Flow Measurements (various sources)
Field-Collected
• Paper Forms
• Diagrams
Ground-Level Digital Images
Traditional Photograph Prints
GPS
Aerial Digital Images
Data
JSATEMP Stream Temperature Model
Relational Database Management System (RDBMS)
Ground-Level Digital Image Library
GIS Database
Aerial Digital Image Library
Guadalupe Environmental Monitoring System (GEMS)

All data are stored digitally. Most of the monitoring data are stored, analyzed, and output in a relational database management system (RDBMS). Special types of data, such as JSATEMP stream temperature model (JSATEMP model) data and GPS data, are stored in other formats. Both within RDBMS and between different types of data, data are linked through the use of identification numbers, such as plant, sampling plot, line transect, and JSATEMP model segment identification numbers. These links allow multiple MMP indicators to be analyzed together, as well as digital images and GIS data related to specific monitoring data to be quickly and easily retrieved.

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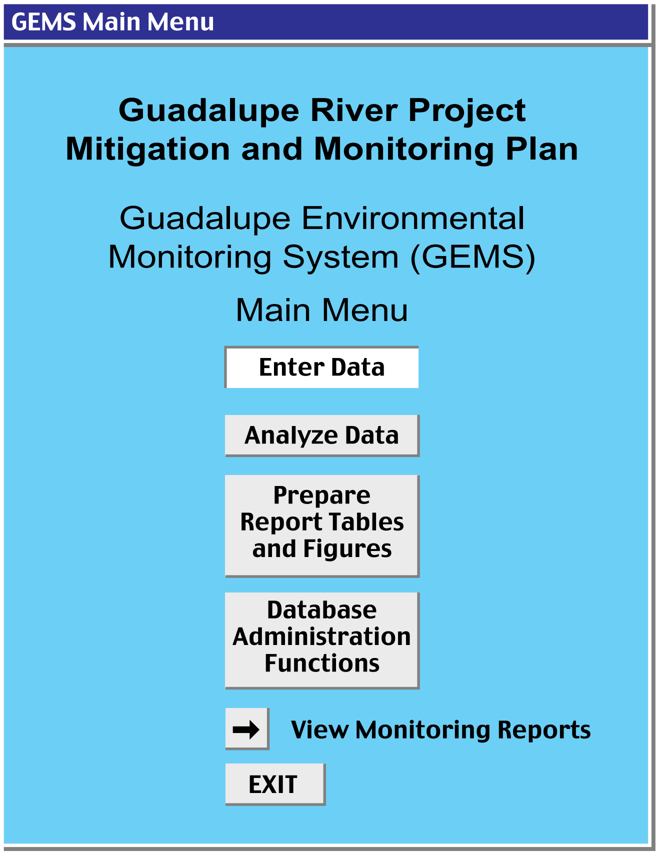
Figure 3-1
Guadalupe Environmental Monitoring System (GEMS) Overview



Guadalupe River Project
Mitigation and Monitoring Plan

Guadalupe Environmental
Monitoring System (GEMS)

Main Menu

Enter Data
Analyze Data
Prepare Report Tables and Figures
Database Administration Functions
➡ View Monitoring Reports
EXIT

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Figure 3-2
GEMS Main Menu

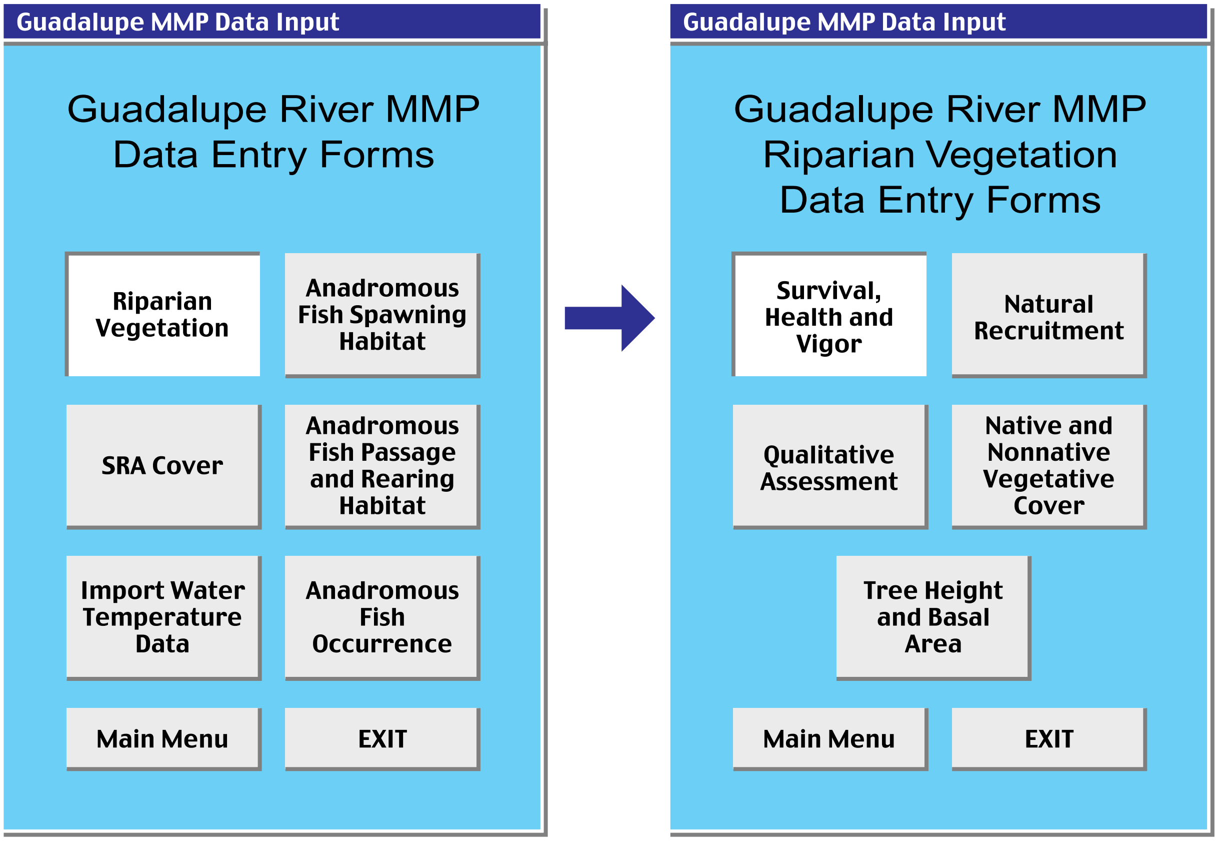
Guadalupe MMP Data Input
Guadalupe River MMP Data Entry Forms
Riparian Vegetation
Anadromous Fish Spawning Habitat
SRA Cover
Anadromous Fish Passage and Rearing Habitat
Import Water Temperature Data
Anadromous Fish Occurrence
Main Menu
EXIT
Guadalupe MMP Data Input
Guadalupe River MMP Riparian Vegetation Data Entry Forms
Survival, Health and Vigor
Natural Recruitment
Qualitative Assessment
Native and Nonnative Vegetative Cover
Tree Height and Basal Area
Main Menu
EXIT

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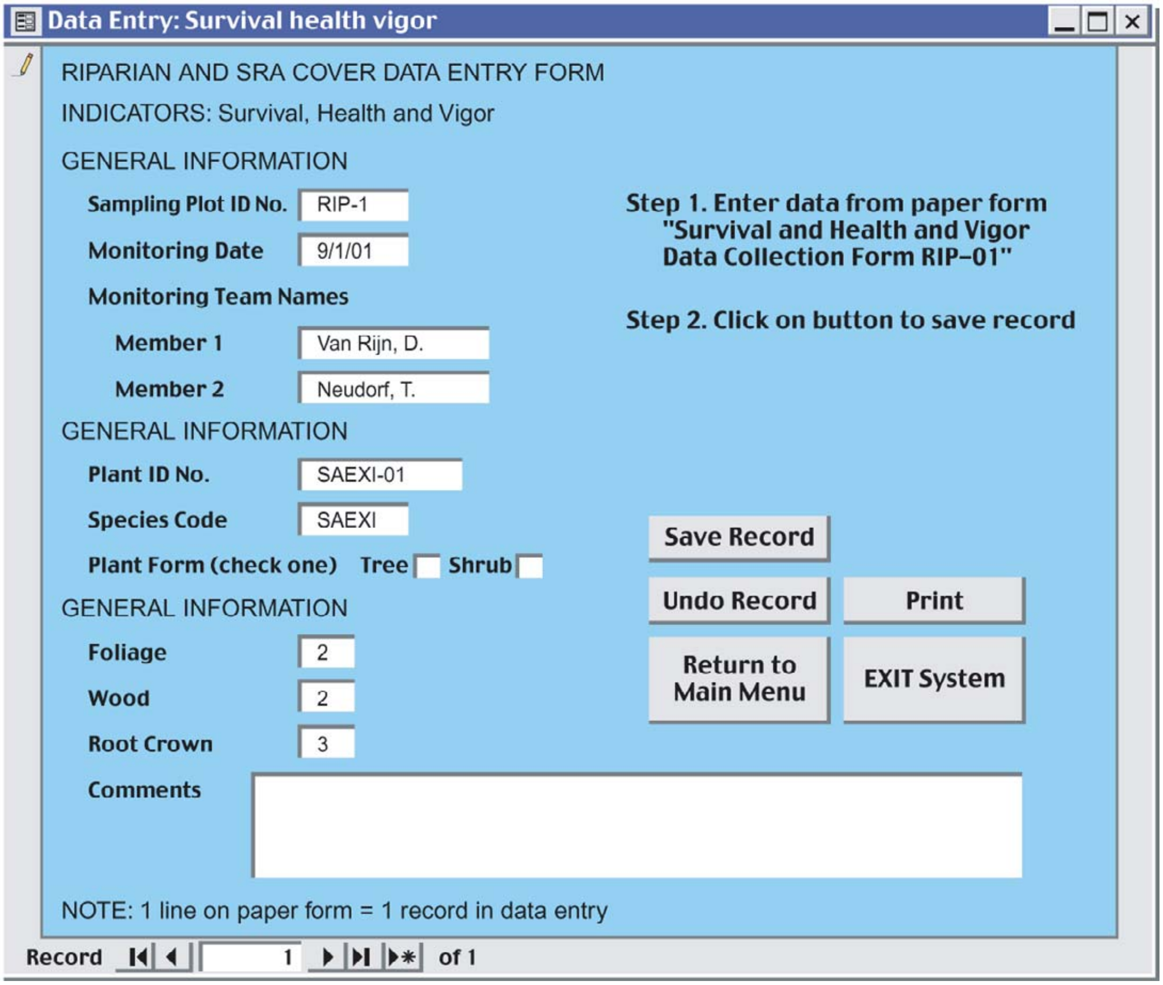
Figure 3-3
GEMS Main Data Entry Menu and
Riparian Vegetation Monitoring Indicators Data Entry Menu



RIPARIAN AND SRA COVER DATA ENTRY FORM

INDICATORS: Survival, Health and Vigor

GENERAL INFORMATION

Sampling Plot ID No. RIP-1

Monitoring Date 9/1/01

Monitoring Team Names

Member 1 Van Rijn, D.

Member 2 Neudorf, T.

GENERAL INFORMATION

Plant ID No. SAEXI-01

Species Code SAEXI

Plant Form (check one) Tree ☐ Shrub ☐

GENERAL INFORMATION

Foliage 2

Wood 2

Root Crown 3

Comments

NOTE: 1 line on paper form = 1 record in data entry

Step 1. Enter data from paper form "Survival and Health and Vigor Data Collection Form RIP-01"

Step 2. Click on button to save record

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Figure 3-4
Sample GEMS Data Entry Form

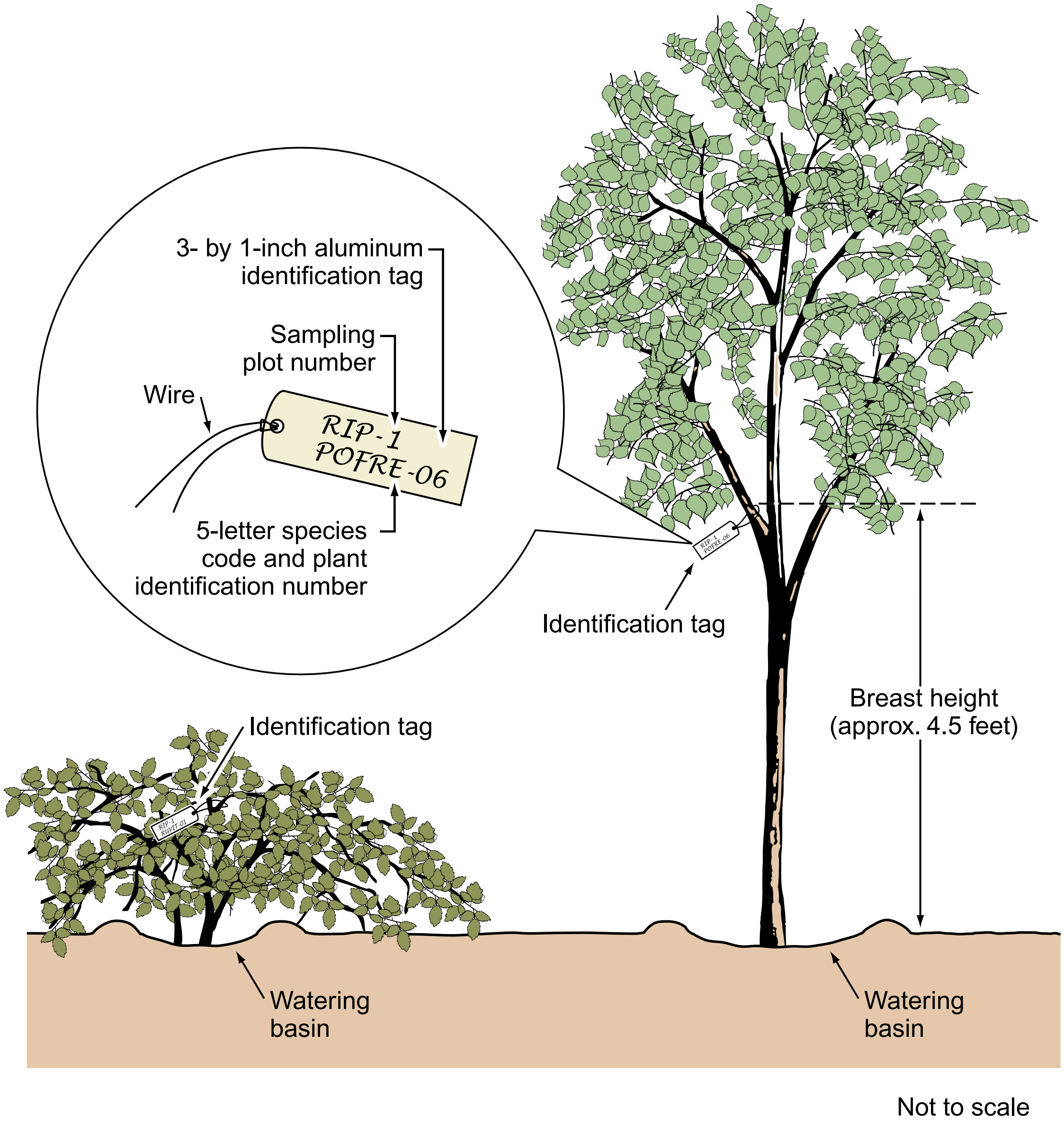

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Figure 4-1
Preferred Location of Identification Tag and Standard Labeling

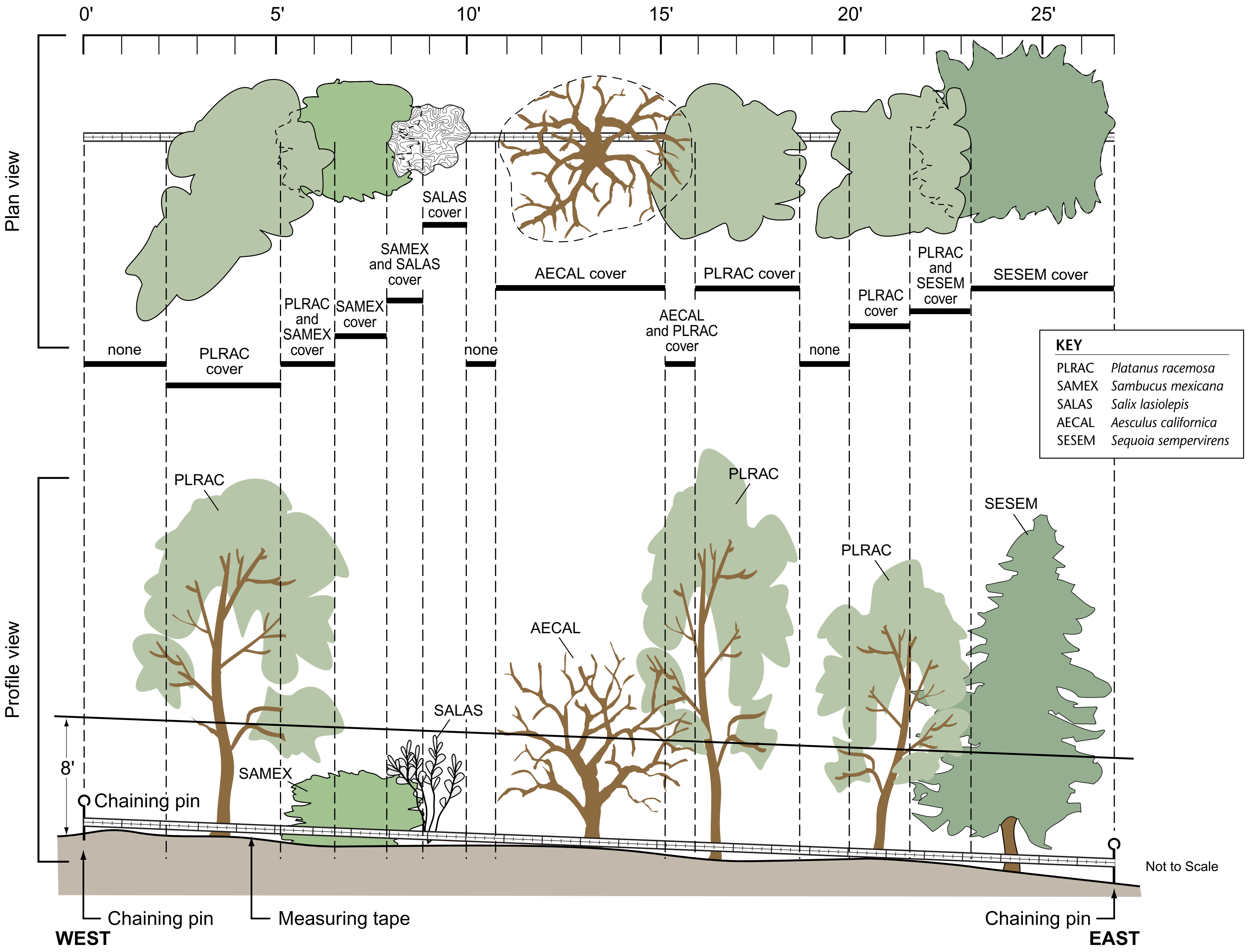

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Figure 4-2
Measuring Vegetative Cover Using the Line Intercept Method

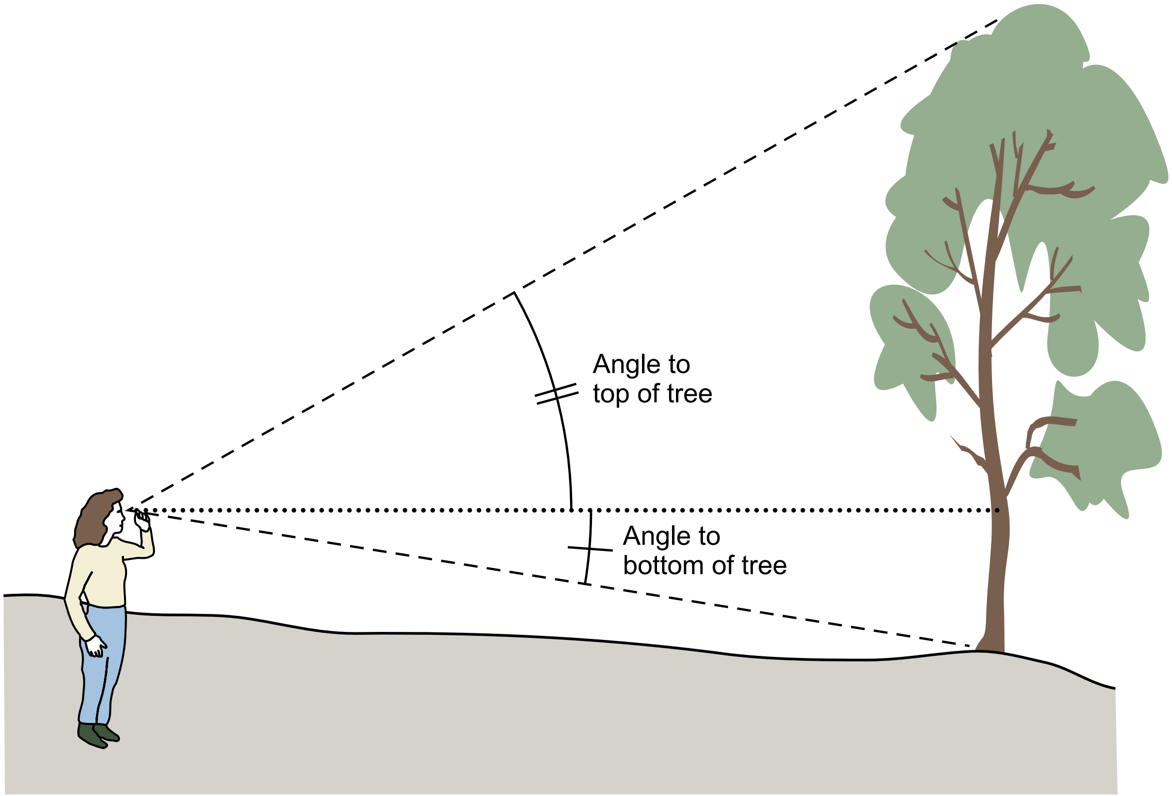

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Figure 4-3
Measuring Tree Height Using a Clinometer

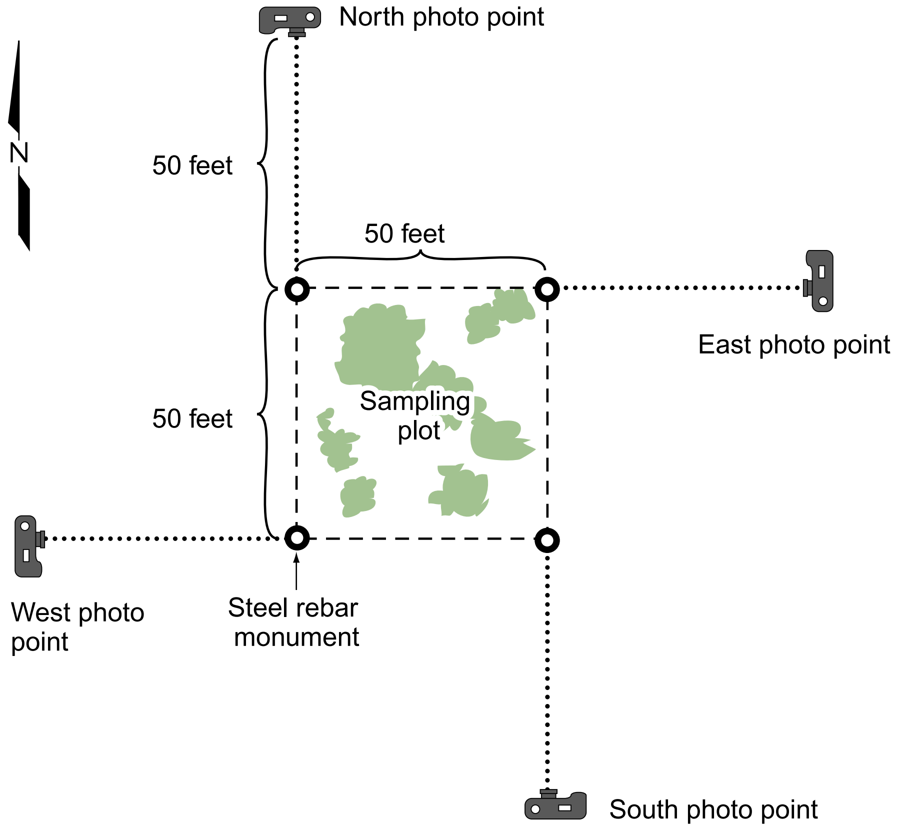

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Figure 4-4
Location of the Four Possible Photo Points for a Riparian Vegetation Sampling Plot

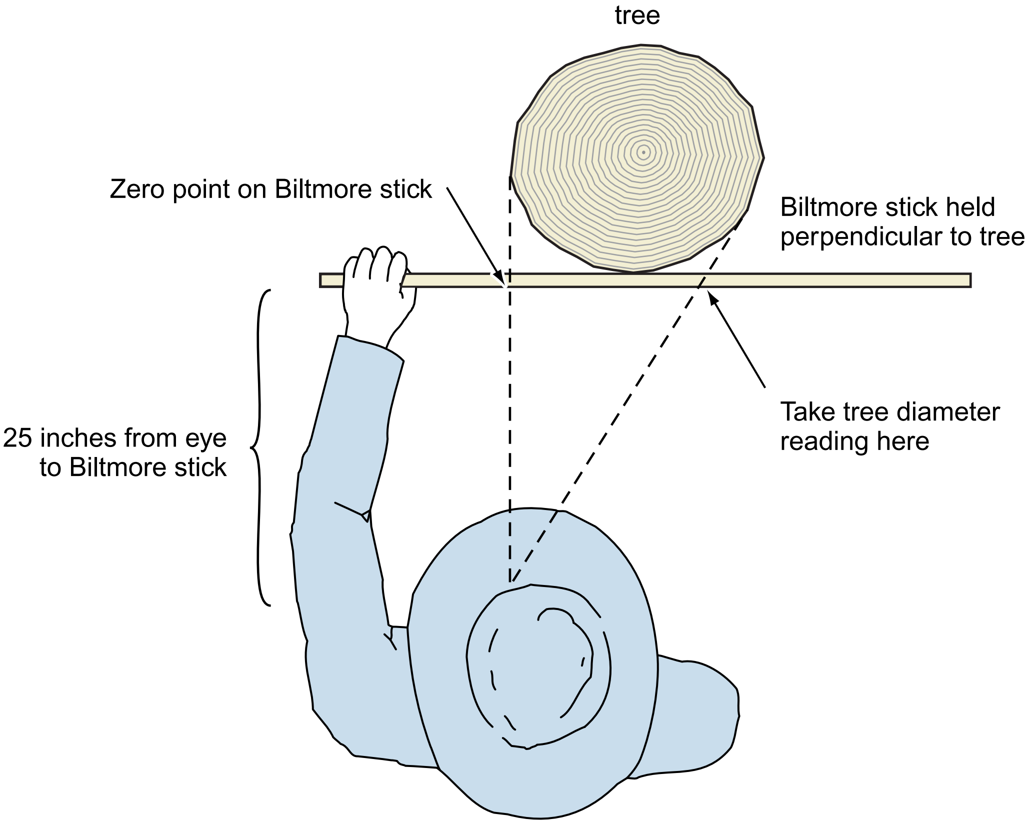
tree
Zero point on Biltmore stick
Biltmore stick held perpendicular to tree
Take tree diameter reading here
25 inches from eye to Biltmore stick

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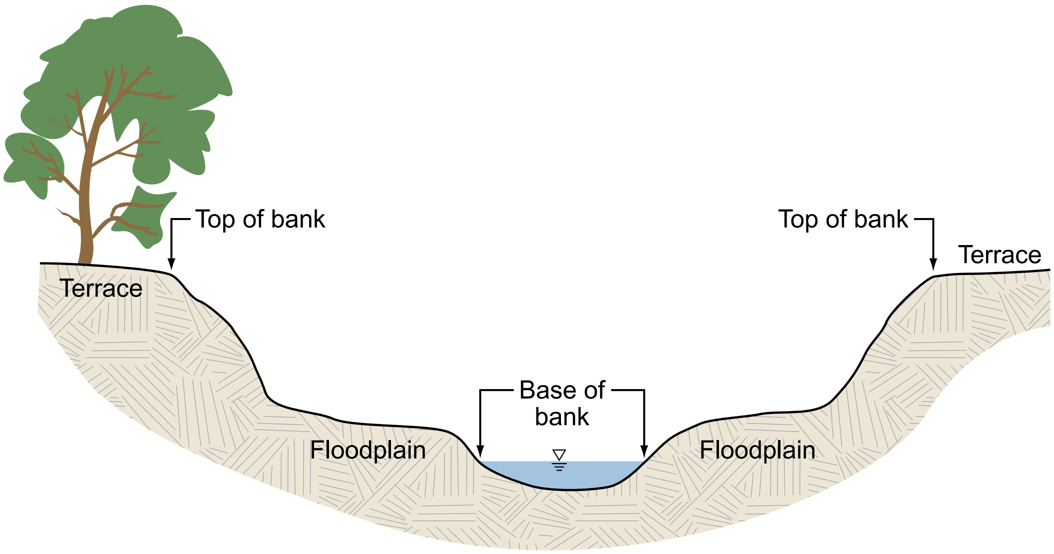
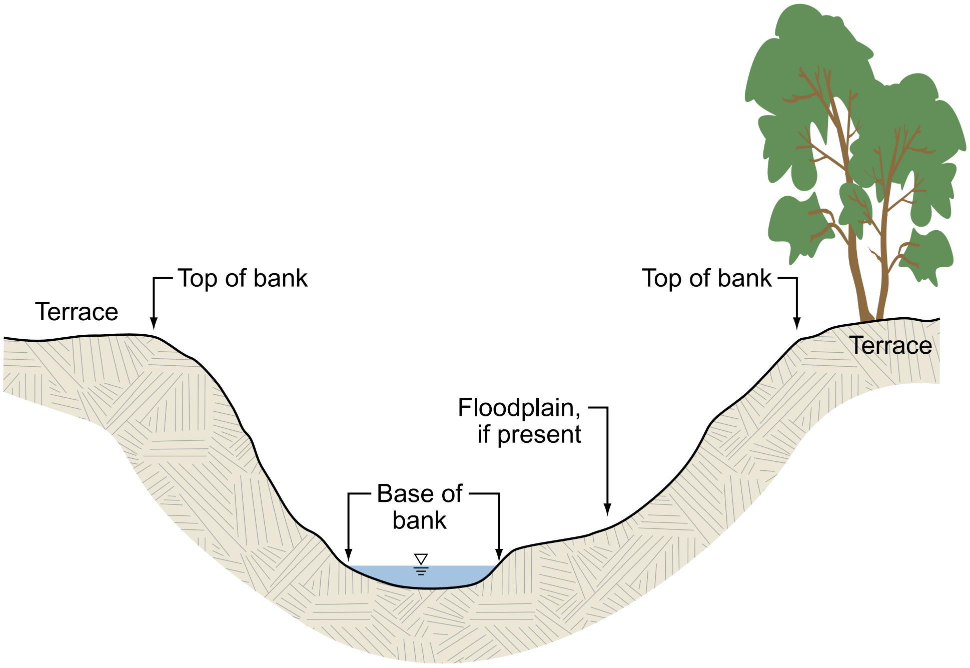
Figure 4-5
Measuring Tree Diameter Using a Biltmore Stick



Typical Cross-Sectional View in Reach A and Guadalupe Creek



Typical Cross-Sectional View in Segments 1–3

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Figure 5-1
Typical Streambank Features in Segments 1–3, Reach A, and Guadalupe Creek

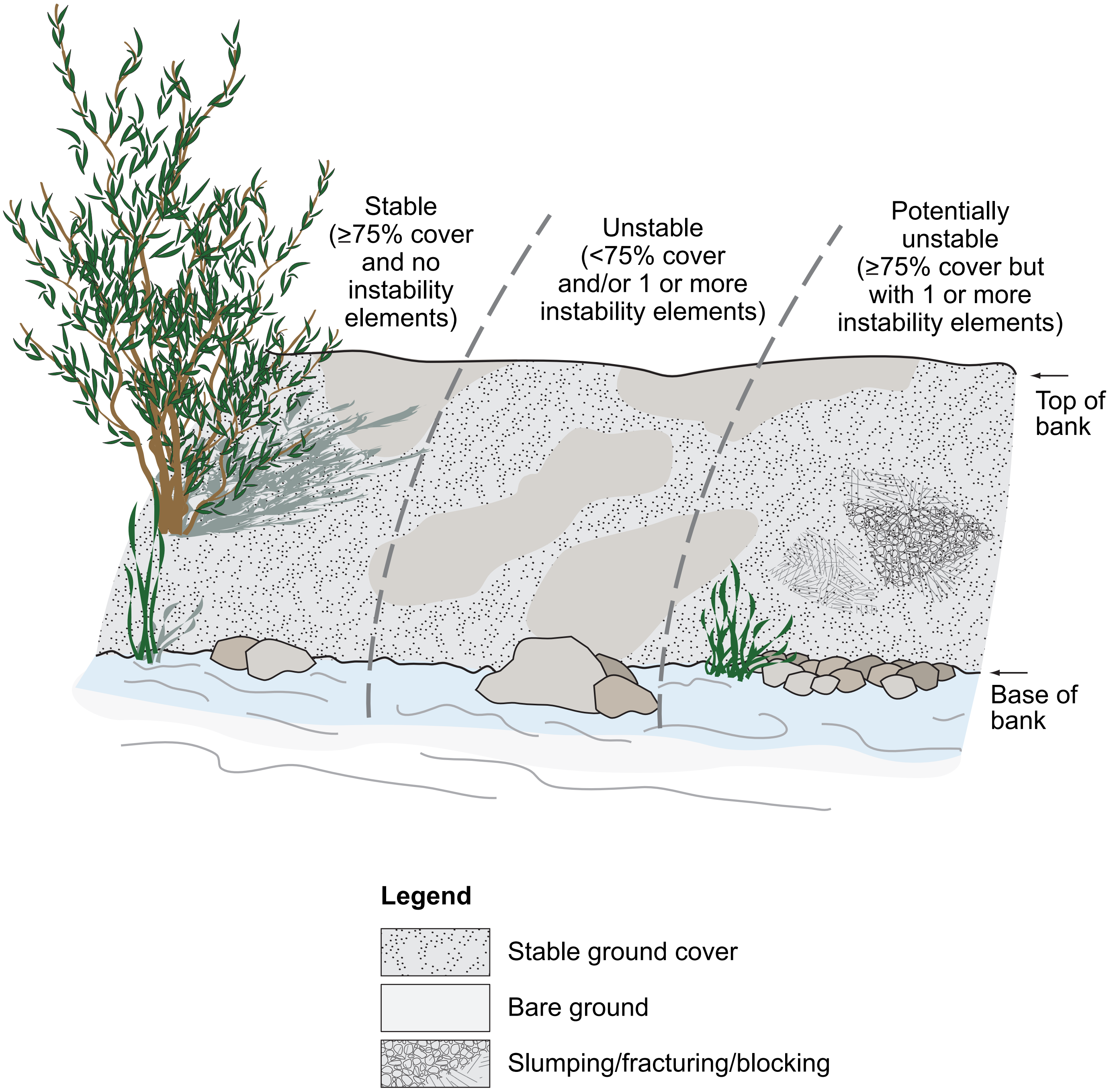
Stable (≥75% cover and no instability elements)
Unstable (<75% cover and/or 1 or more instability elements)
Potentially unstable (≥75% cover but with 1 or more instability elements)
Top of bank
Base of bank
Legend
Stable ground cover
Bare ground
Slumping/fracturing/blocking

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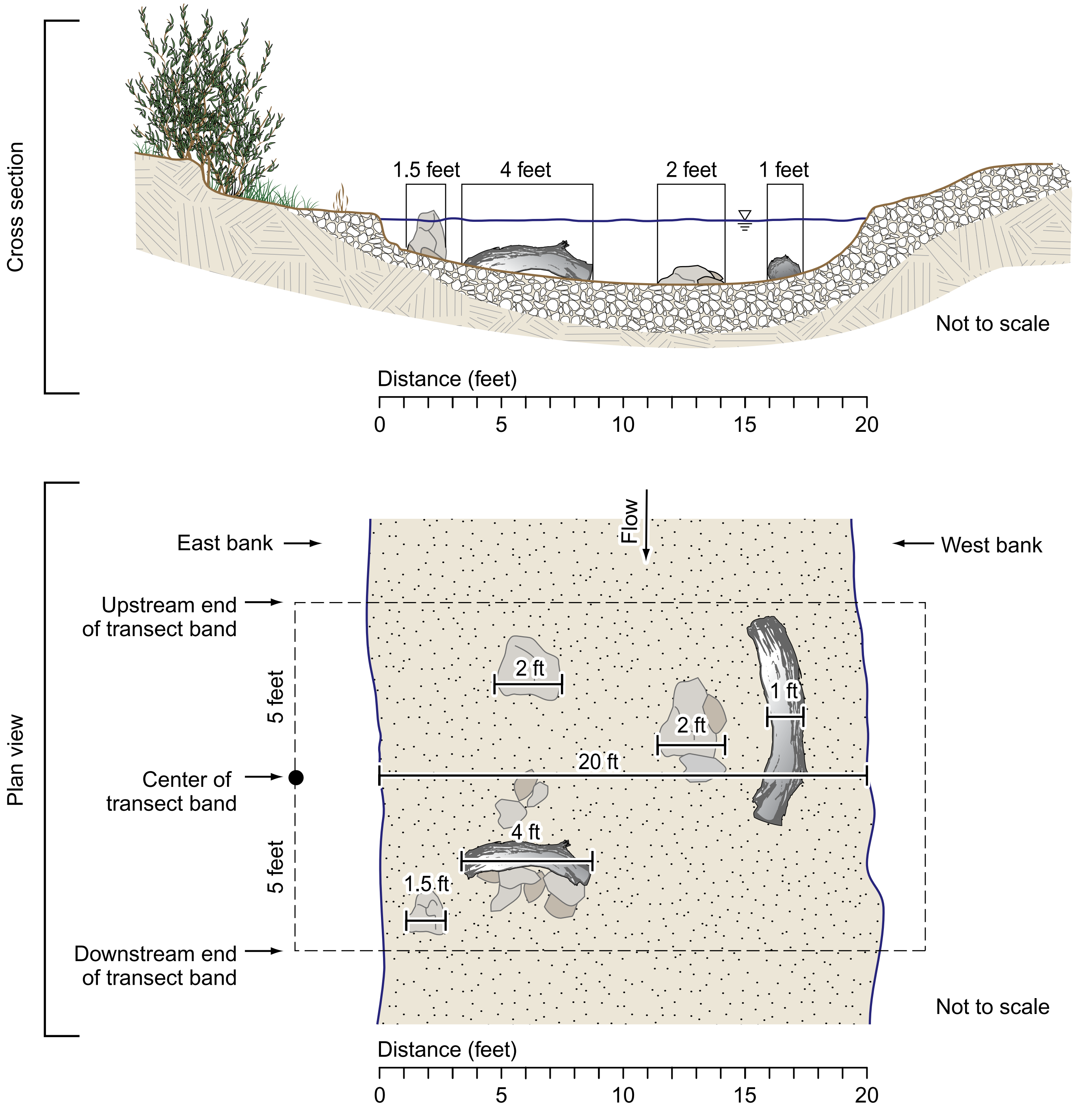
Figure 5-2
Examples of Bank Stability Segments



Calculations:

Total cover = 1.5 feet + 4 feet + 2 feet + 1 foot = 8.5 feet

Percent cover = (8.5 feet 20 feet) x 100 = 43%

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Figure 5-3
Determining Percent Instream Cover at a Transect Band

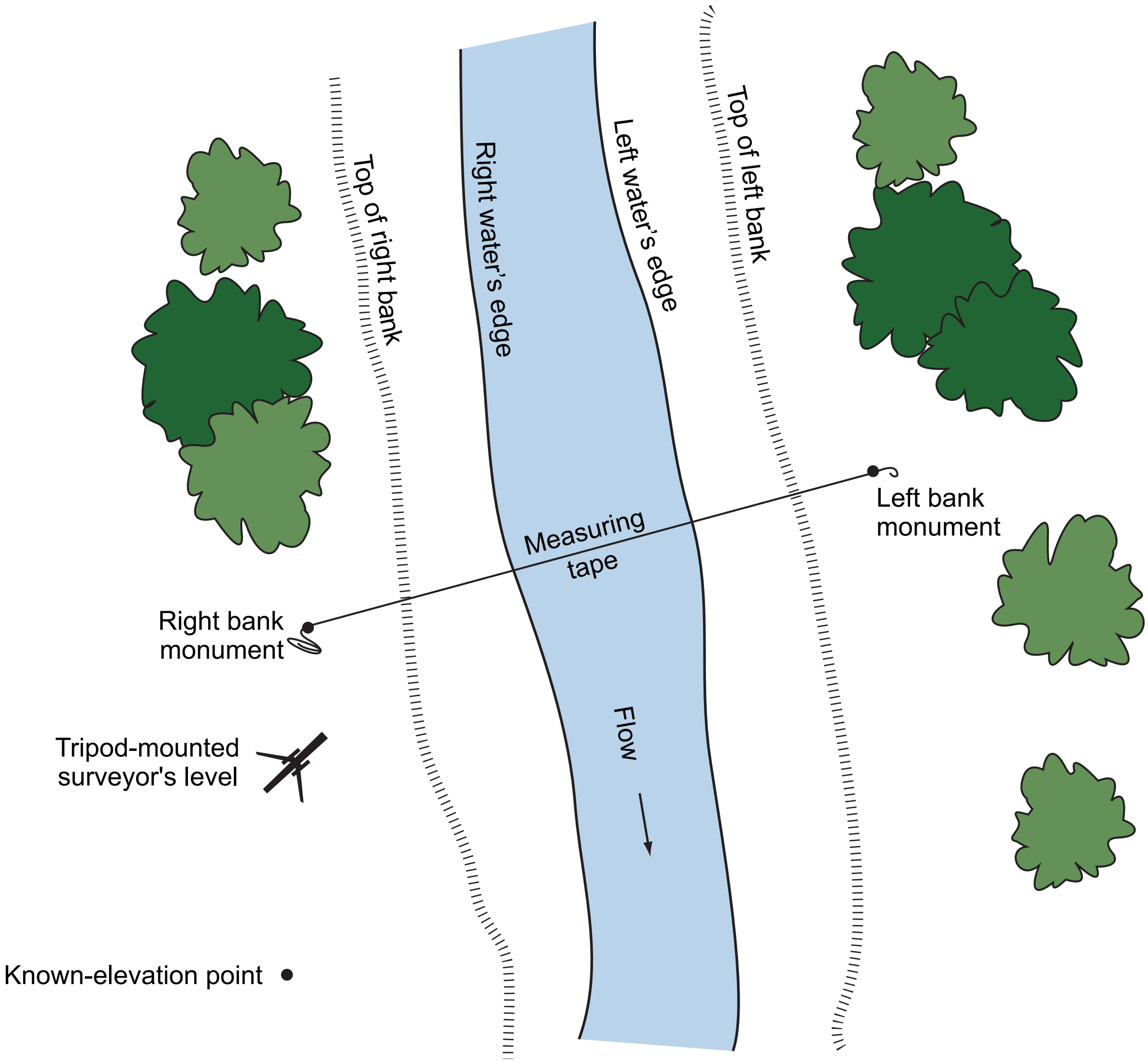

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Figure 5-4
Plan View of Cross-Section Survey

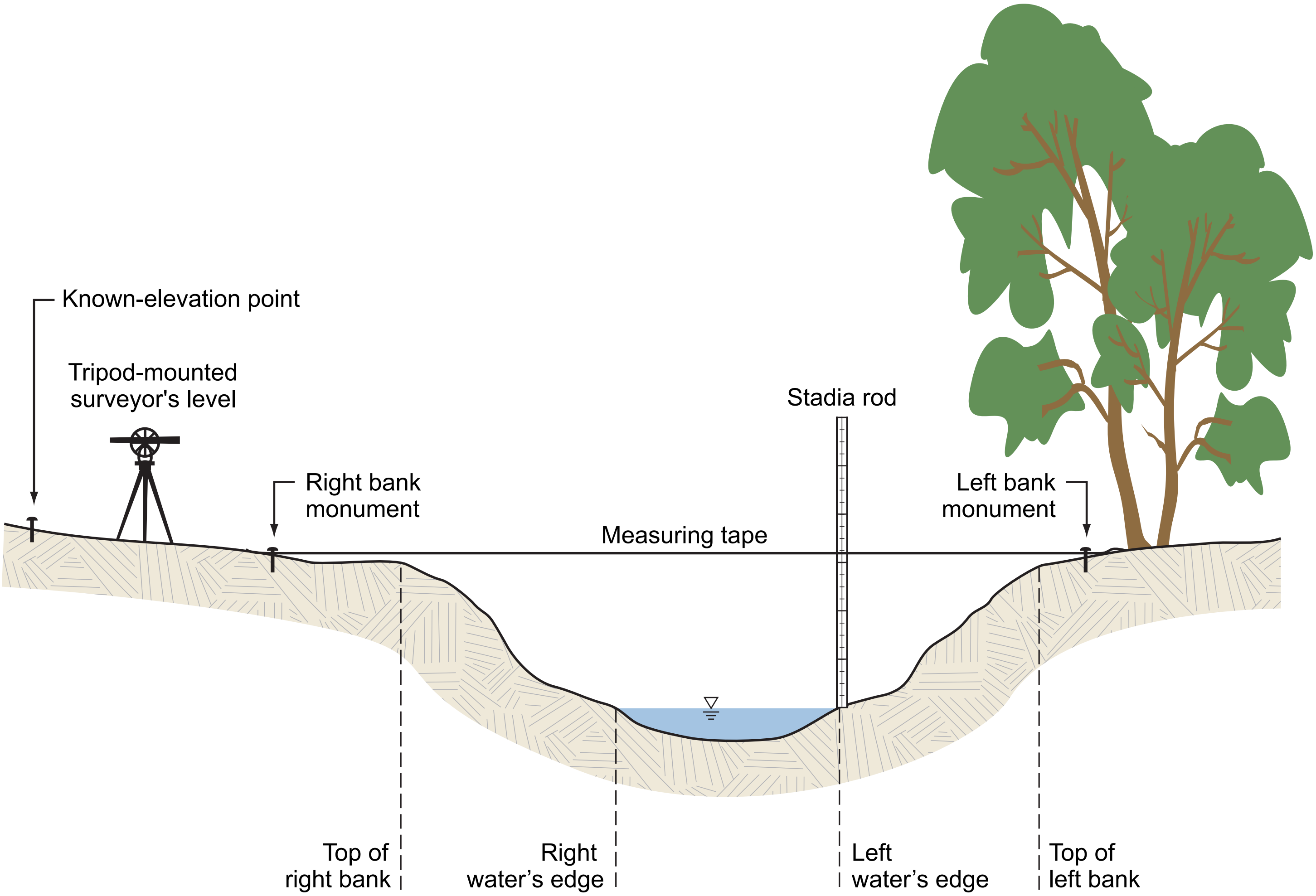

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Figure 5-5
Profile View of Stream Channel Facing Upstream

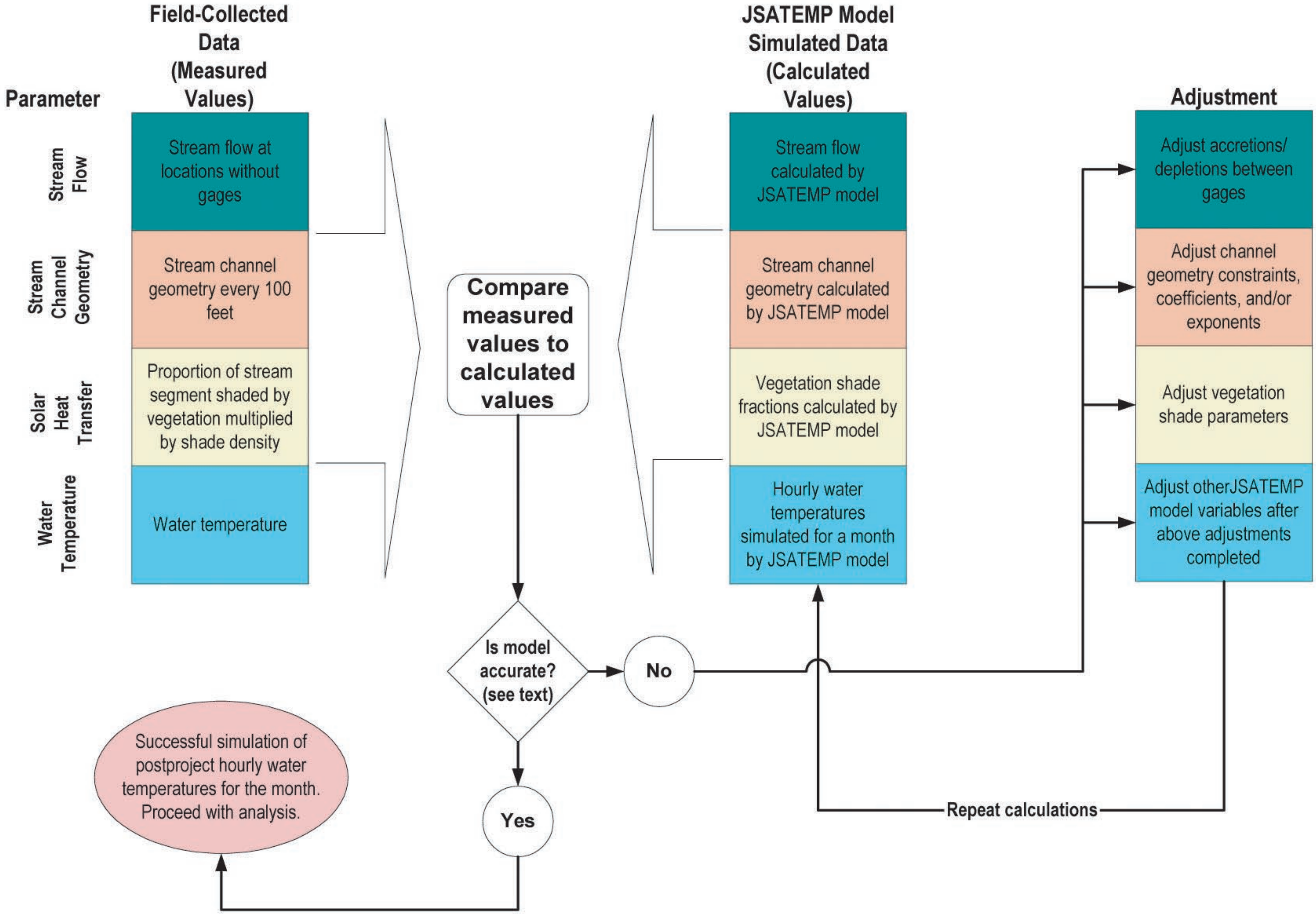
Parameter
Field-Collected Data (Measured Values)
JSATEMP Model Simulated Data (Calculated Values)
Adjustment
Stream Flow
Stream Channel Geometry
Solar Heat Transfer
Water Temperature
Stream flow at locations without gages
Stream channel geometry every 100 feet
Proportion of stream segment shaded by vegetation multiplied by shade density
Water temperature
Compare measured values to calculated values
Stream flow calculated by JSATEMP model
Stream channel geometry calculated by JSATEMP model
Vegetation shade fractions calculated by JSATEMP model
Hourly water temperatures simulated for a month by JSATEMP model
Adjust accretions/ depletions between gages
Adjust channel geometry constraints, coefficients, and/or exponents
Adjust vegetation shade parameters
Adjust otherJSATEMP model variables after above adjustments completed
Is model accurate? (see text)
No
Yes
Repeat calculations
Successful simulation of postproject hourly water temperatures for the month. Proceed with analysis.

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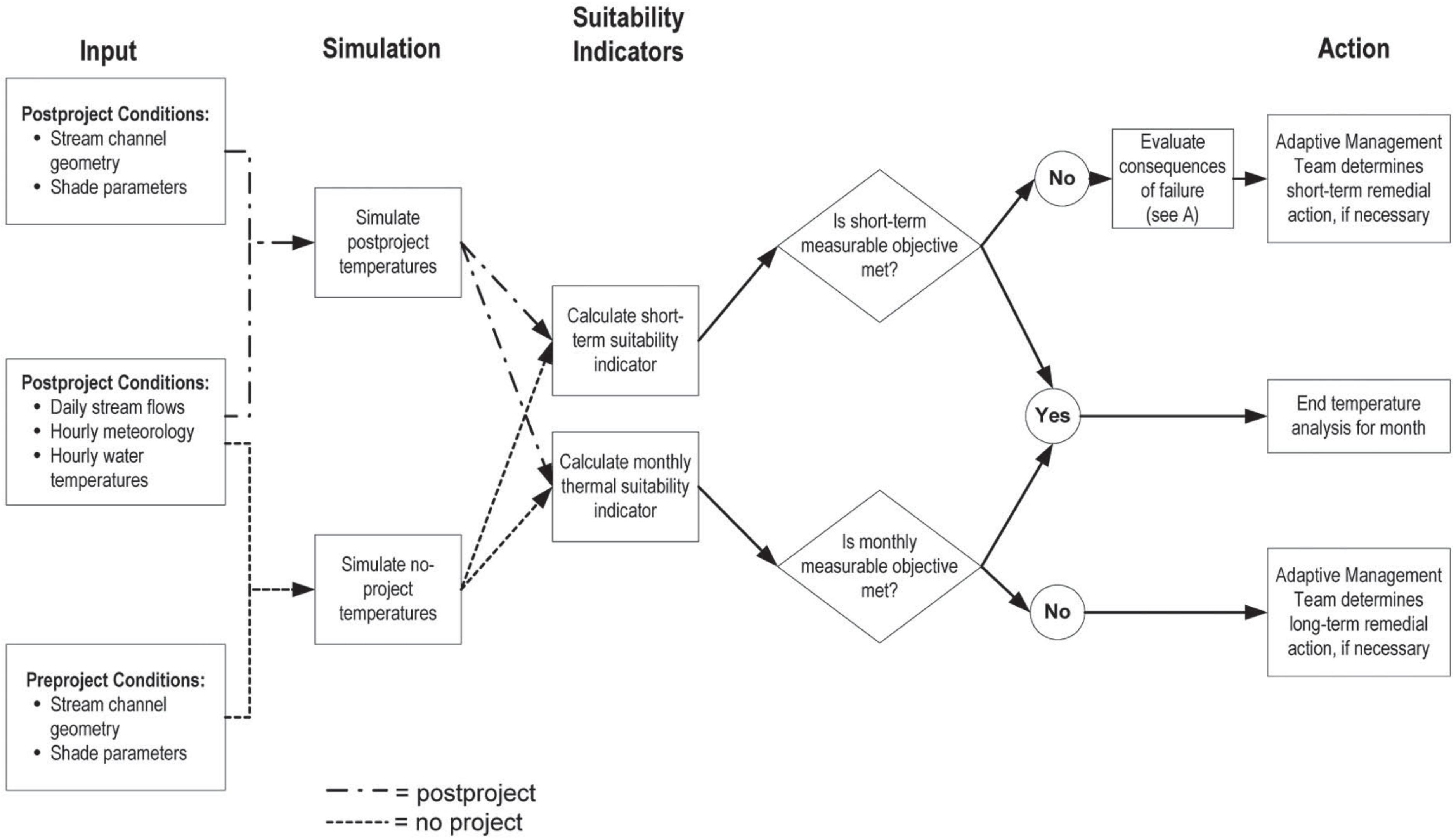
Figure 6-1
Basis for Adjusting Parameters in the JSATEMP Stream Temperature Model


Input
Simulation
Suitability Indicators
Action
Postproject Conditions:
• Stream channel geometry
• Shade parameters
Postproject Conditions:
• Daily stream flows
• Hourly meteorology
• Hourly water temperatures
Preproject Conditions:
• Stream channel geometry
• Shade parameters
Simulate postproject temperatures
Simulate no-project temperatures
Calculate short-term suitability indicator
Calculate monthly thermal suitability indicator
Is short-term measurable objective met?
Is monthly measurable objective met?
No
Yes
No
Evaluate consequences of failure (see A)
Adaptive Management Team determines short-term remedial action, if necessary
End temperature analysis for month
Adaptive Management Team determines long-term remedial action, if necessary
— · — = postproject
------- = no project

A. Provide Adaptive Management Team with a clear description of the magnitude and location of water temperature change that caused the failure to meet the measurable objective. The Adaptive Management Team will consider this information, along with fisheries information on life stage presence, mobility, and temperature tolerances, to determine whether remedial actions are necessary. This evaluation is necessary because the short-term suitability index depends on thresholds, so small changes in water temperature may cause a failure to meet the measurable objective.

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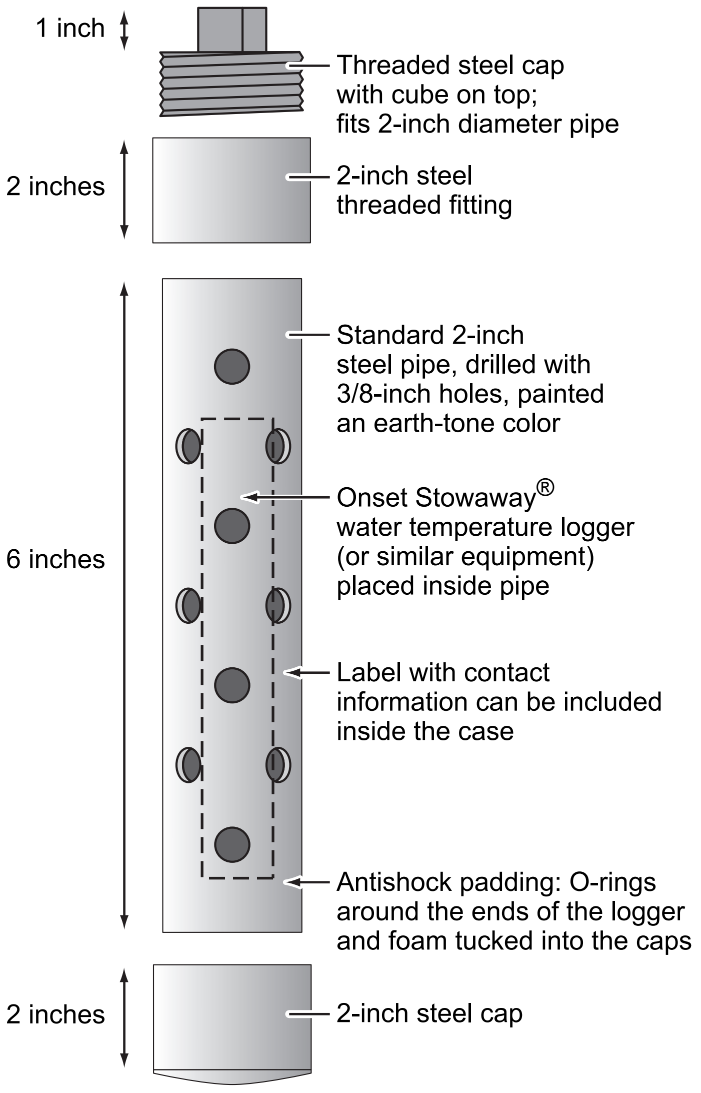
Figure 6-2
Water Temperature Analysis for Steelhead and Chinook Salmon


1 inch
Threaded steel cap with cube on top; fits 2-inch diameter pipe
2 inches
2-inch steel threaded fitting
6 inches
Standard 2-inch steel pipe, drilled with 3/8-inch holes, painted an earth-tone color
Onset Stowaway® water temperature logger (or similar equipment) placed inside pipe
Label with contact information can be included inside the case
Antishock padding: O-rings around the ends of the logger and foam tucked into the caps
2 inches
2-inch steel cap

Not to scale

0F028.00-300

Figure 6-3
Schematic Diagram of Water Temperature Logger Case

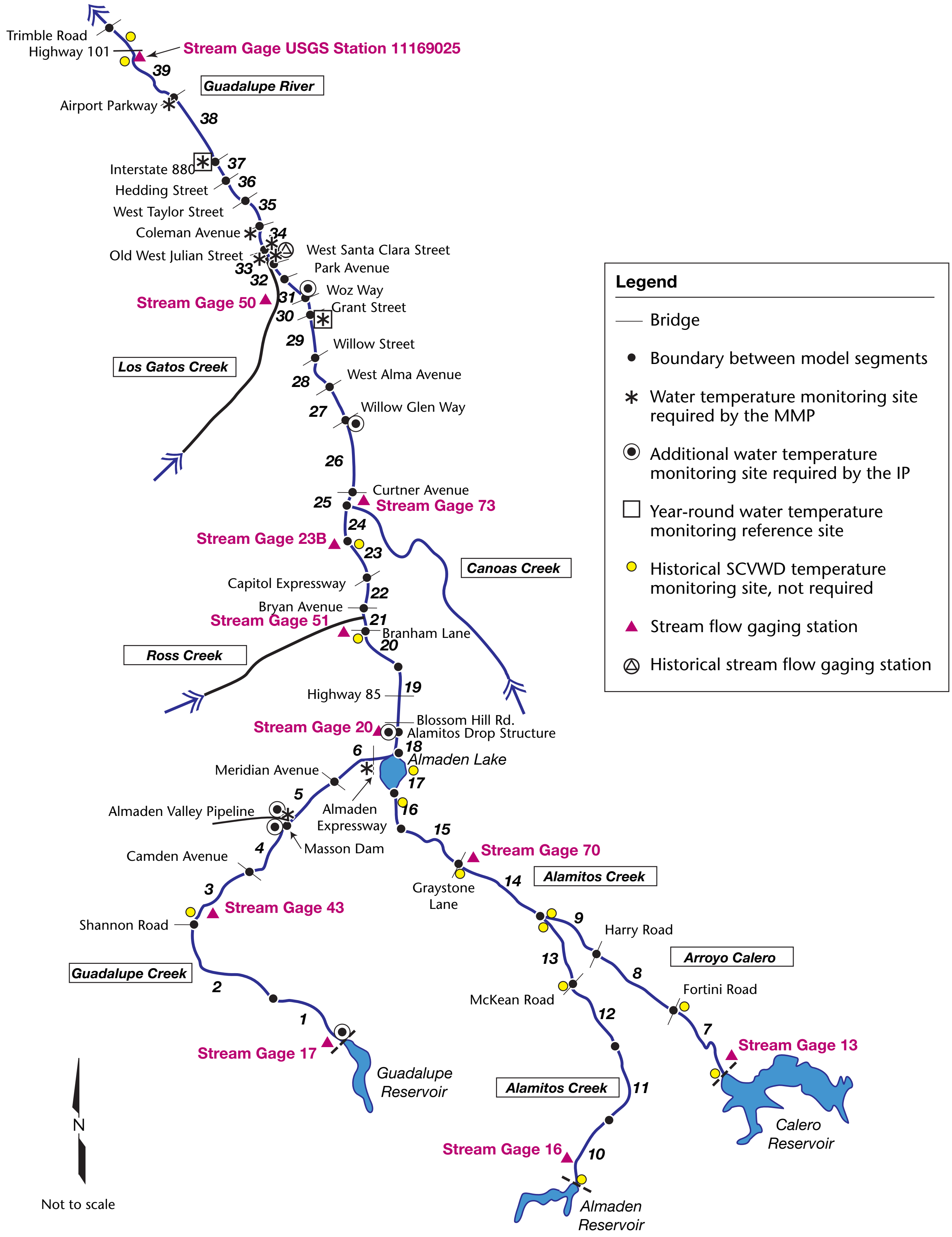


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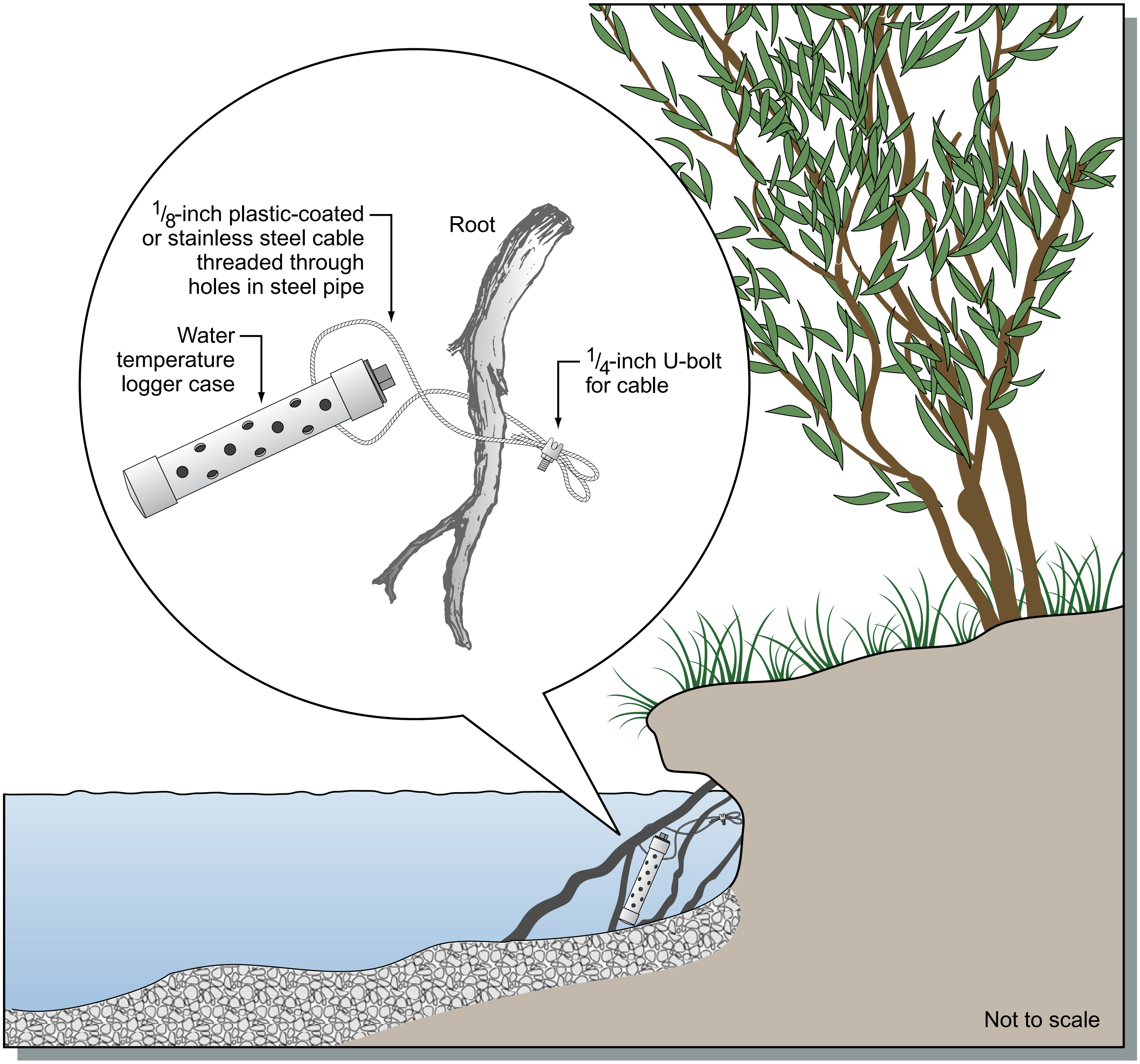
Figure 6-4
Model Segments Used in the JSATEMP Stream Temperature Model, Including Water Temperature Monitoring Sites and Stream Flow Gaging Stations


1/8-inch plastic-coated or stainless steel cable threaded through holes in steel pipe
Root
Water temperature logger case
1/4-inch U-bolt for cable
Not to scale

Note: Cable appears loose for illustration purposes. Logger must be securely attached to in-stream structures and U-bolt.

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Figure 6-5
Placement of Water Temperature Logger Case in Stream Channel

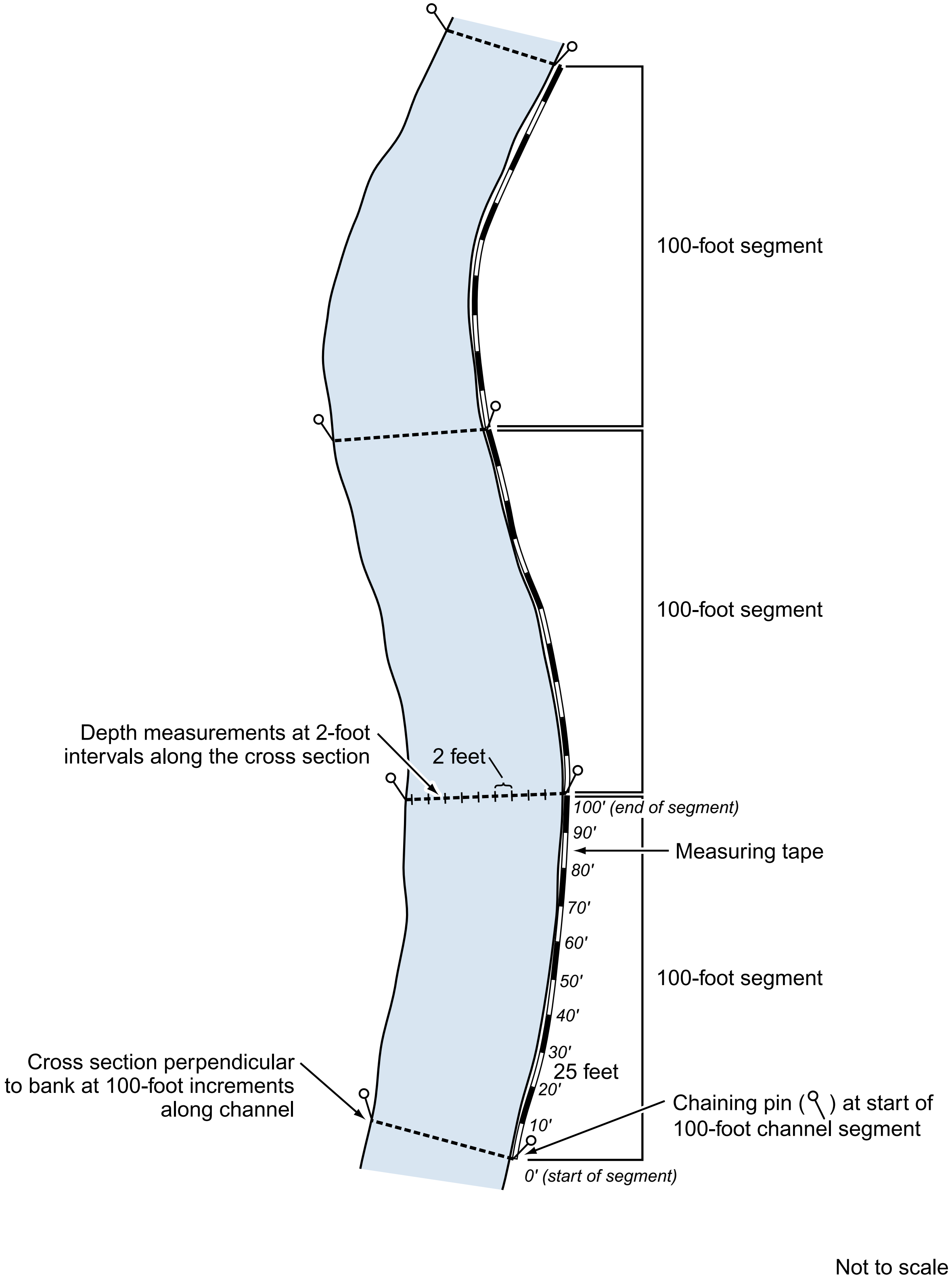
100-foot segment
100-foot segment
Depth measurements at 2-foot intervals along the cross section
2 feet
100' (end of segment)
90'
Measuring tape
80'
70'
60'
50'
100-foot segment
40'
30'
Cross section perpendicular to bank at 100-foot increments along channel
25 feet
20'
Chaining pin ( ) at start of 100-foot channel segment
10'
0' (start of segment)
Not to scale

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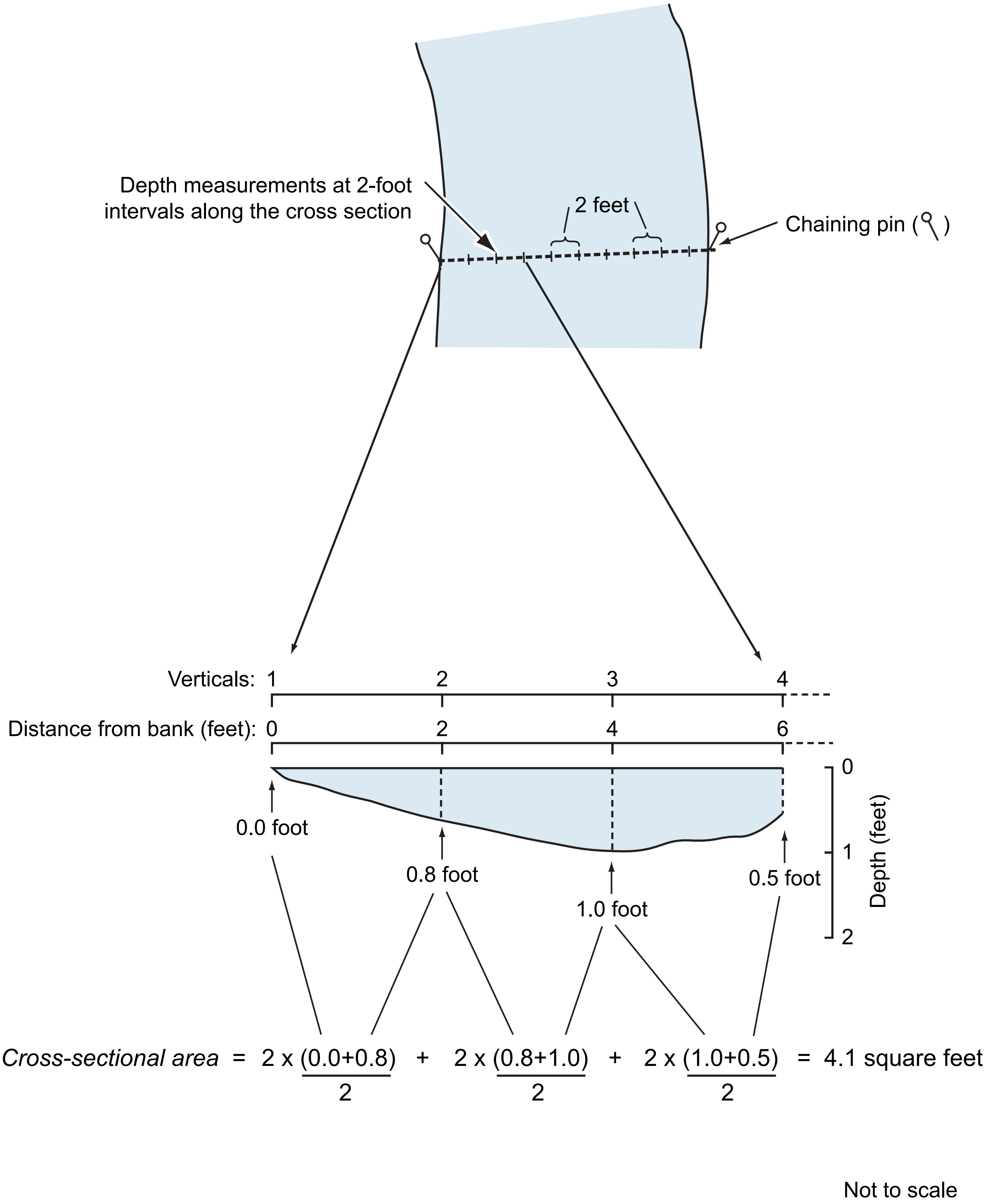
Figure 6-6
Measuring Stream Channel Geometry


Depth measurements at 2-foot intervals along the cross section
2 feet
Chaining pin (⚲)
Verticals: 1 2 3 4
Distance from bank (feet): 0 2 4 6
0.0 foot
0.8 foot
1.0 foot
0.5 foot
0
1
2
Depth (feet)
Cross-sectional area = $2 \times \frac{(0.0+0.8)}{2} + 2 \times \frac{(0.8+1.0)}{2} + 2 \times \frac{(1.0+0.5)}{2}$ = 4.1 square feet
Not to scale

0F028.00-300

Figure 6-7
Sample Calculation of Cross-Sectional Area

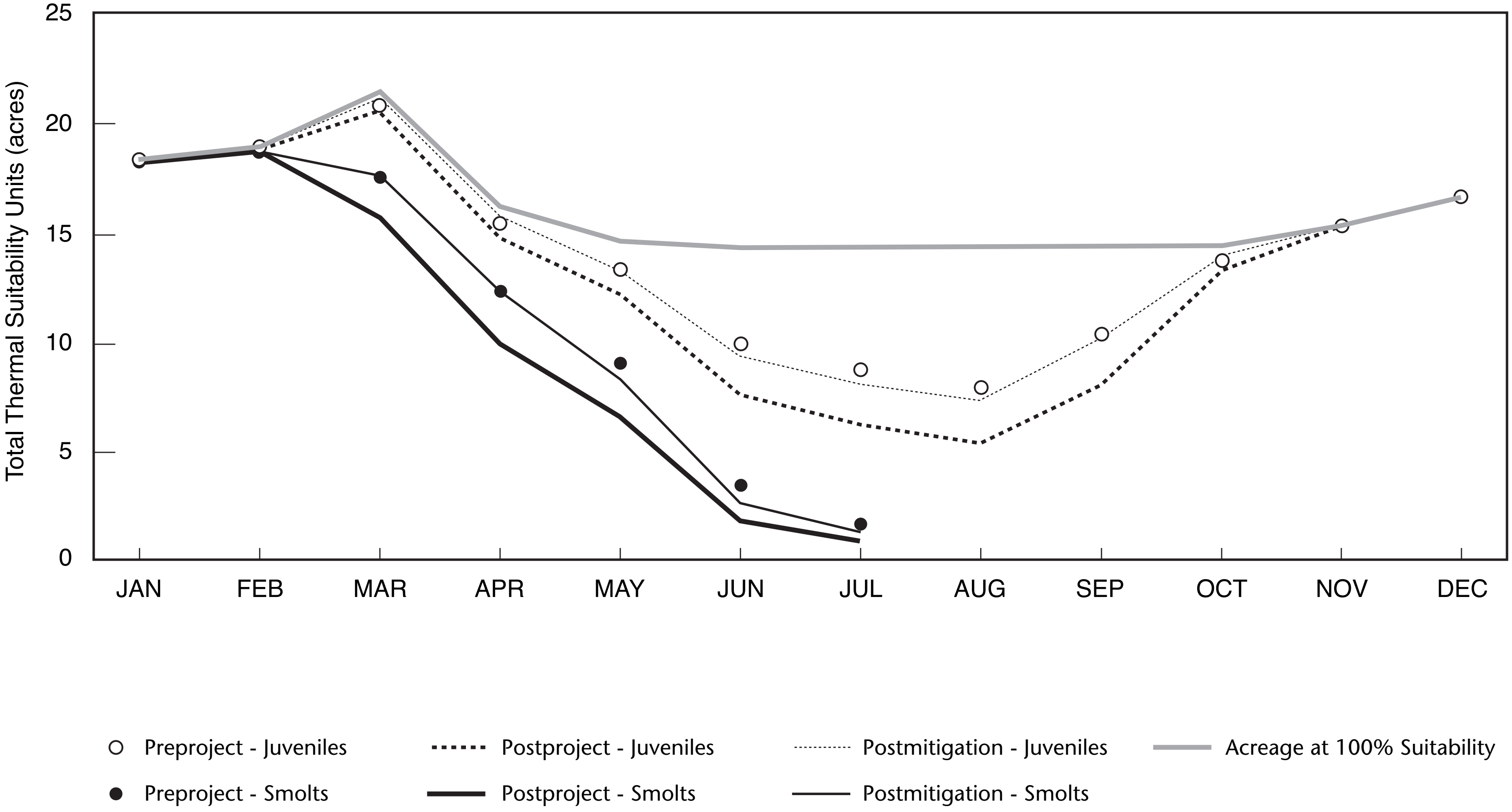


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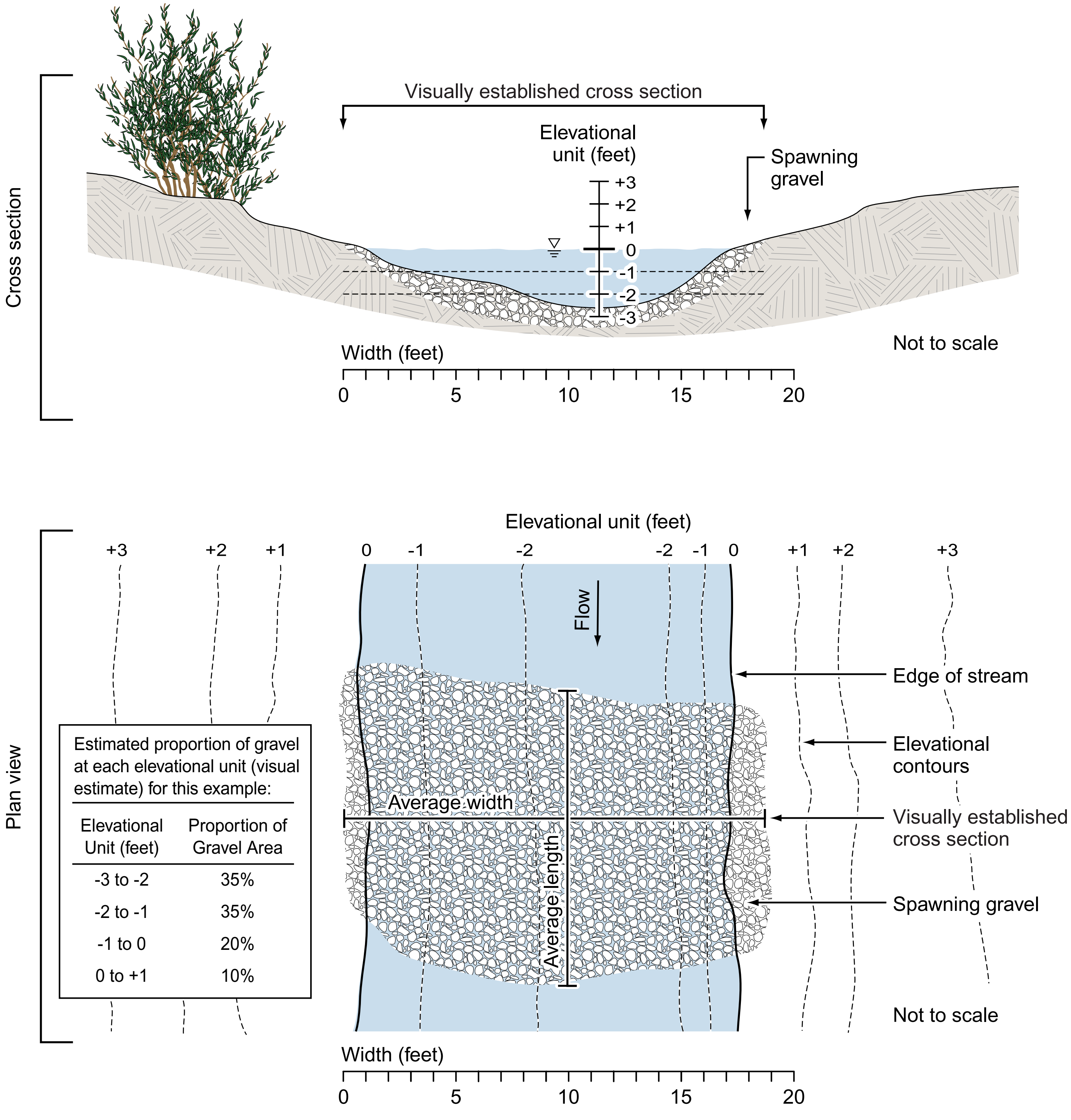
Figure 6-8
Total Thermal Suitability Units for 2 Steelhead Life Stages
Simulated for the Dry/Median Year in All Stream Segments Affected by the Guadalupe River Project



Estimated proportion of gravel at each elevational unit (visual estimate) for this example:

Elevational Unit (feet)	Proportion of Gravel Area
-3 to -2	35%
-2 to -1	35%
-1 to 0	20%
0 to +1	10%

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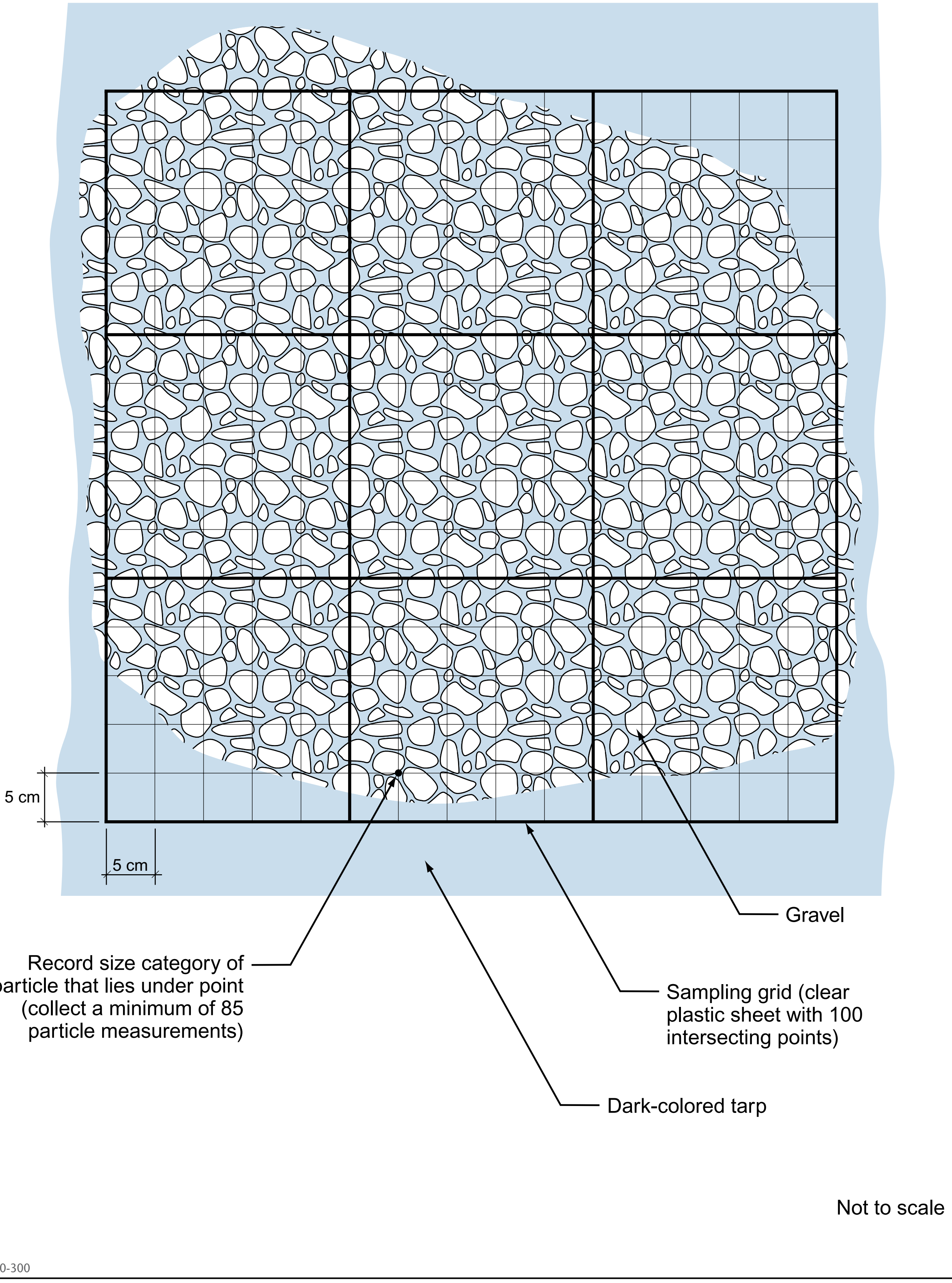
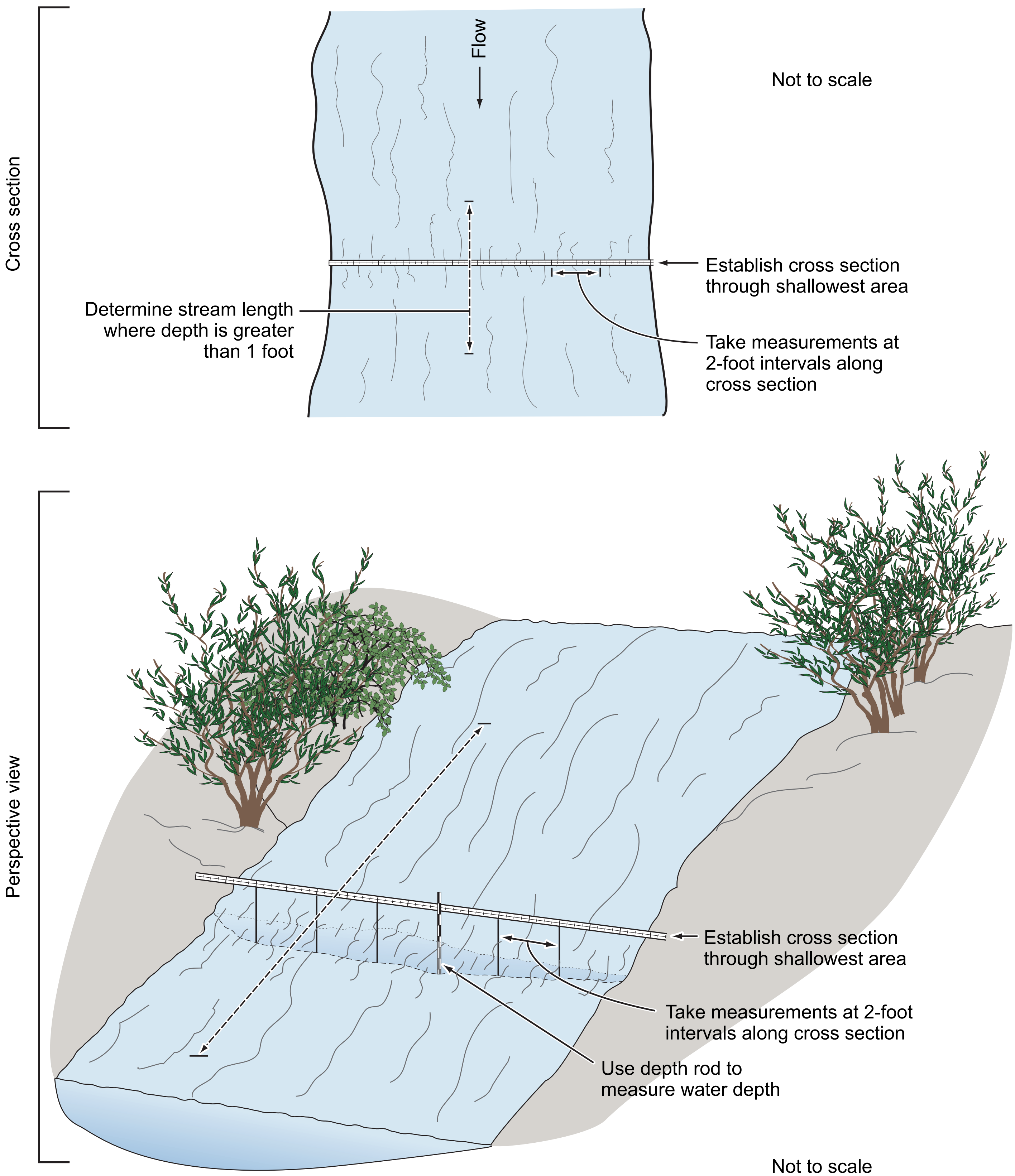
Figure 7-1
Determining the Proportion of Spawning Gravel at Elevational Units


5 cm
5 cm
Gravel
Record size category of particle that lies under point (collect a minimum of 85 particle measurements)
Sampling grid (clear plastic sheet with 100 intersecting points)
Dark-colored tarp
Not to scale

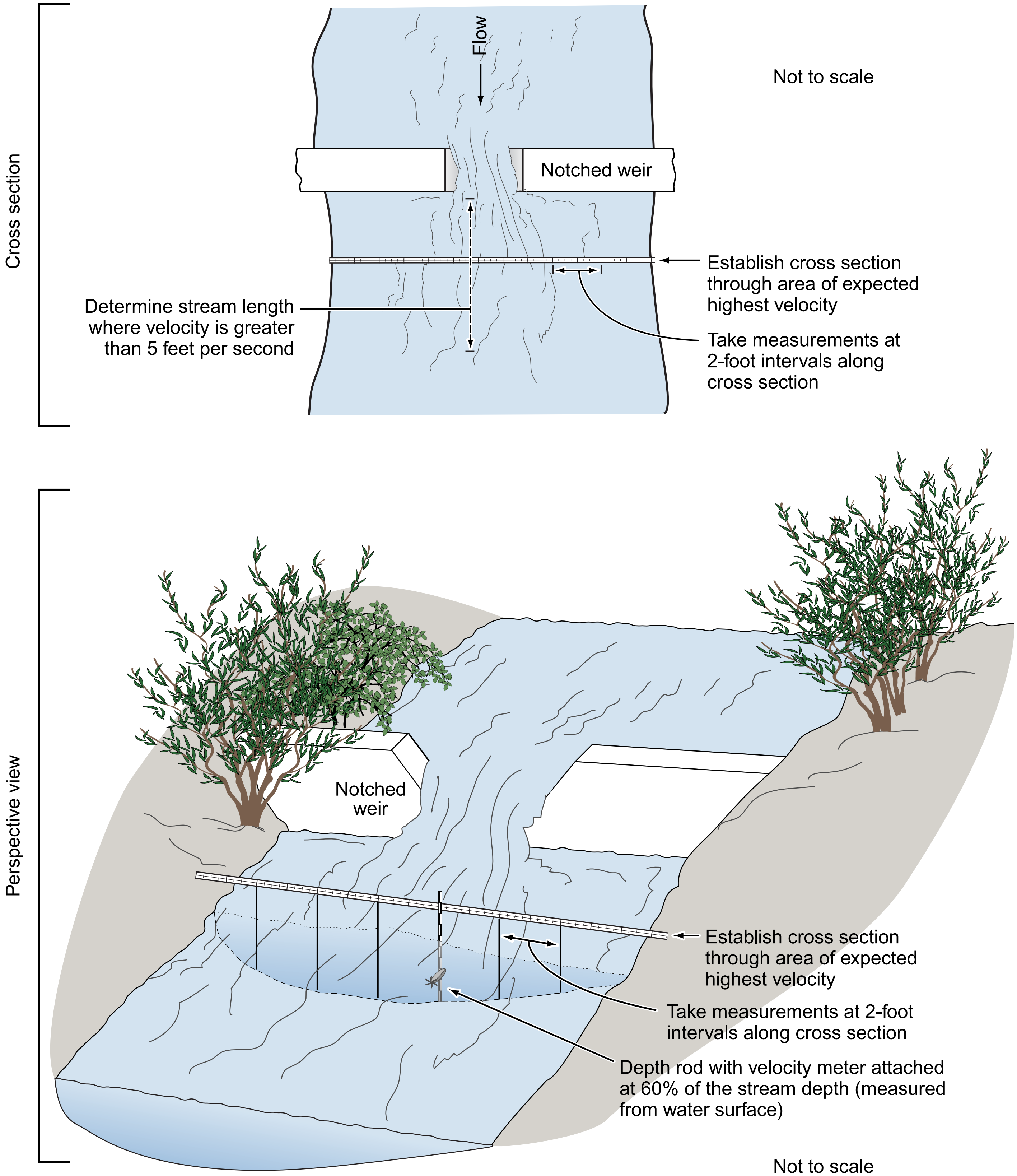
0F028.00-300

Figure 7-2
Determining Particle Size for Spawning Gravel Quality Sample


Cross section
Flow
Not to scale
Establish cross section through shallowest area
Determine stream length where depth is greater than 1 foot
Take measurements at 2-foot intervals along cross section
Perspective view
Establish cross section through shallowest area
Take measurements at 2-foot intervals along cross section
Use depth rod to measure water depth
Not to scale

0F028.00-300

Figure 8-1
Depth Barrier Field Measurements, Using Shallow Riffle as an Example


Cross section
Flow
Not to scale
Notched weir
Establish cross section through area of expected highest velocity
Determine stream length where velocity is greater than 5 feet per second
Take measurements at 2-foot intervals along cross section
Perspective view
Notched weir
Establish cross section through area of expected highest velocity
Take measurements at 2-foot intervals along cross section
Depth rod with velocity meter attached at 60% of the stream depth (measured from water surface)
Not to scale

0F028.00-300

Figure 8-2
Velocity Barrier Field Measurements, Using Notched Weir as an Example

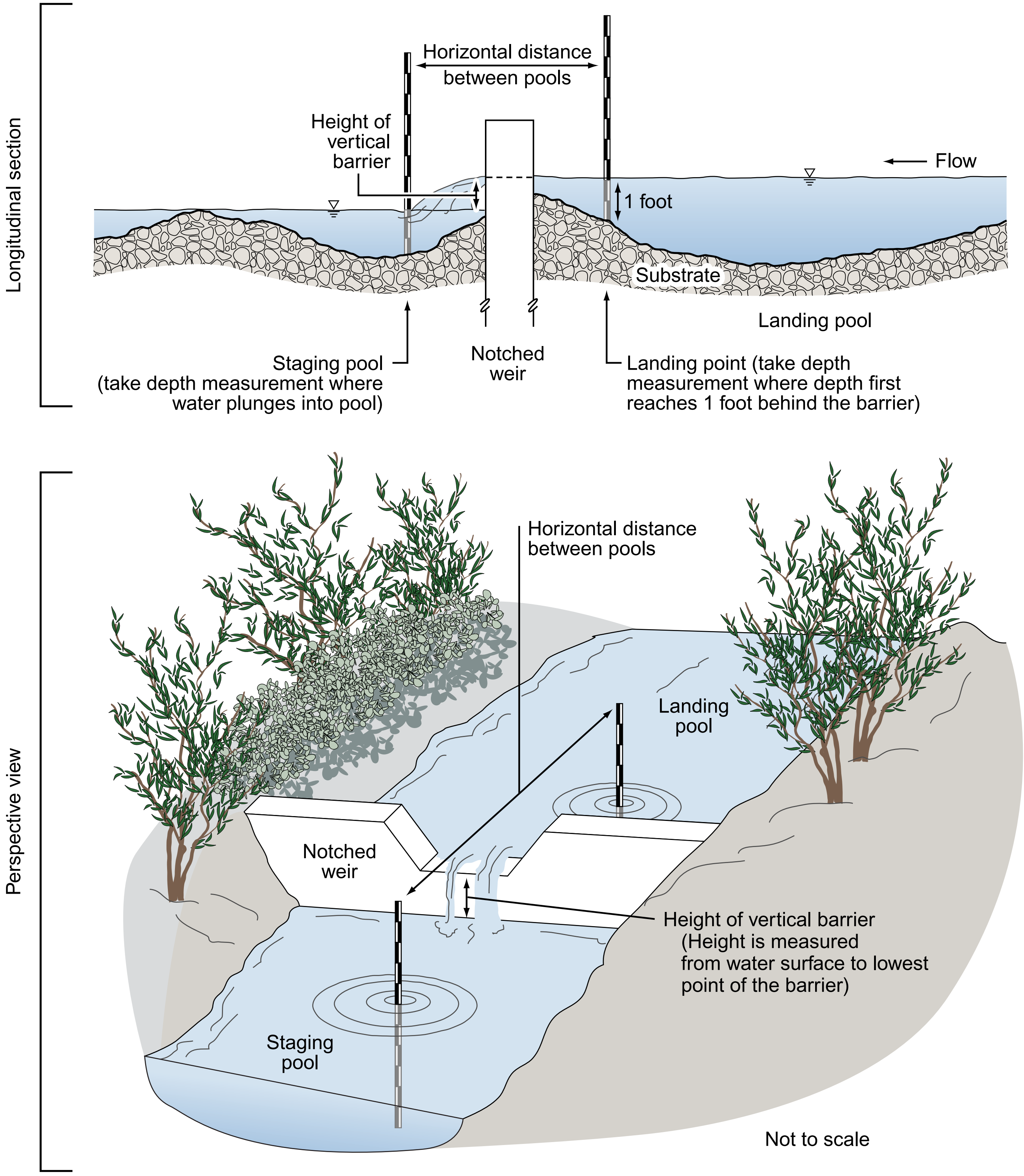
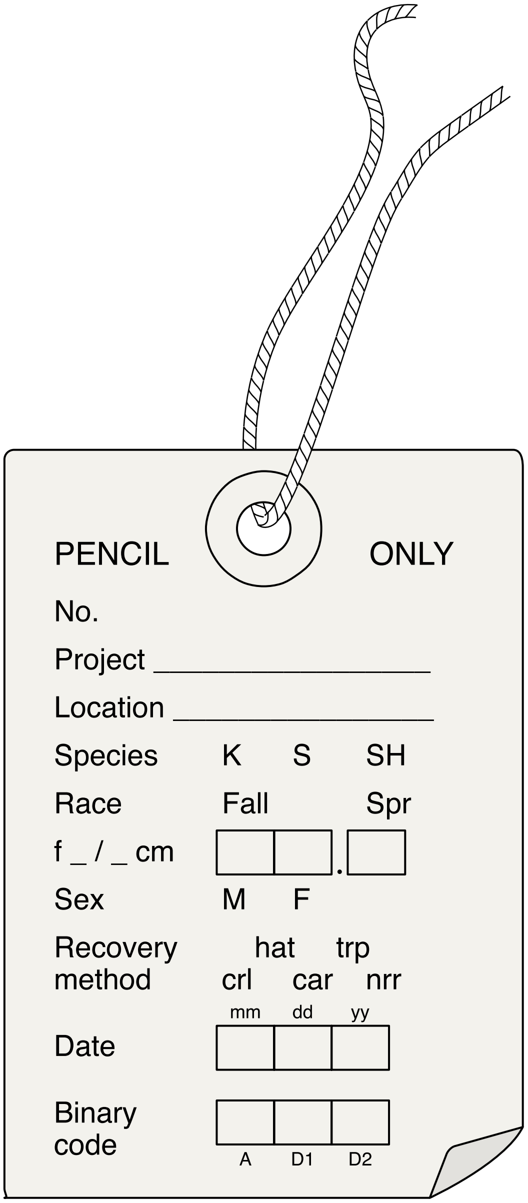

Longitudinal section
Horizontal distance between pools
Height of vertical barrier
Flow
1 foot
Substrate
Landing pool
Staging pool (take depth measurement where water plunges into pool)
Notched weir
Landing point (take depth measurement where depth first reaches 1 foot behind the barrier)
Perspective view
Horizontal distance between pools
Landing pool
Notched weir
Height of vertical barrier (Height is measured from water surface to lowest point of the barrier)
Staging pool
Not to scale

Figure 8-3
Vertical Barrier Field Measurements, Using Notched Weir as an Example



PENCIL ONLY

No.

Project ________________

Location ________________

Species K S SH

Race Fall Spr

f _ / _ cm ☐☐.☐

Sex M F

Recovery method hat trp crl car nrr

Date ☐☐☐ (mm dd yy)

Binary code ☐☐☐ (A D1 D2)

Source: Flossi et al. 1998.

Not to scale

0F028.00-300

Figure 9-1
Coded-Wire-Tag Recovery Form